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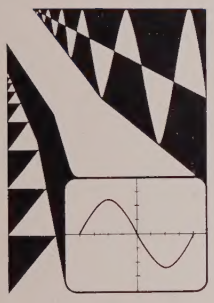

Portable Storage ocsilloscope

PM 3266

Instruction Manual

9499 440 19702

781108

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Instruction manual
Gerätehandbuch
Notice d'emploi 'entretien

Portable dual - trace storage oscilloscope
Tragbarer Zweistrahl - Speicheroszillograf
Oscilloscope, double trace portatif à memoire

PM3266

9499 440 19702

781108

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos réclamations se rapportant á cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Note: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

Bemerkung: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

Remarques: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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Positive feedback

Now you are the user of a Philips test and measuring instrument. We trust that it will give you many years of faithful service. But we would like you to realize one thing: we can only supply the best in T & M equipment with **your** help, user.

We need to know what you have found to be the strong and weak points of this instrument; and we would be very interested to hear about any unusual or elegant applications you have devised for it. Some of this information can be passed on to our design and development departments; and some may be fed back to other users via our bimonthly publication **T & M News**.

May we therefore suggest that you fill in the reply card alongside and send it back to us right now. (or, - even better - make a note in your diary to fill in the reply card in say 6 months. After you have gained some experience in using the instrument in practice). That way, you'll be helping to provide the positive feedback we need to help you!

All contributions that are published will be paid for at current rates; while as an inducement for you to fill in the reply card, we are offering a free subscription to T & M News or a free copy of Part I of our Digital Instrument Course to all who reply.

Erfahrungsaustausch

Meßgeräte müssen sich in der Praxis bewähren und die in sie gesteckten Erwartungen erfüllen; auch bei Ihnen, dem Besitzer eines Geräts aus der Serie der Philips Test- und Meßgeräte. Wir aber können T & M-Geräte nur zu Ihrer vollen Zufriedenheit herstellen, wenn wir alle Ihre Wünsche kennen.

Deshalb interessiert uns Ihre Meinung über die guten und weniger guten Eigenschaften dieses Gerätes. Außerdem suchen wir Erfahrungen über ungewöhnliche oder neue Anwendungsmöglichkeiten. Vielleicht können Sie unseren Entwicklungs- und Konstruktionsabteilungen einen guten Wink geben; vielleicht können wir Ihre Erfahrungen aber auch in unserer Publikation Info-dienst (nur in Deutschland) veröffentlichen, damit auch andere Anwender davon profitieren können.

Deshalb möchten wir Sie bitten, die anhängende Antwortkarte auszufüllen und an uns zurückzusenden. (Entweder gleich oder -noch besser - machen Sie sich eine Notiz auf Ihrem Kalender und schicken die Karte in einem halben Jahr zurück, wenn Sie genügend praktische Erfahrungen mit dem Gerät gesammelt haben). Damit helfen Sie uns, und wir können Ihnen helfen!

Alle veröffentlichten Beiträge werden dem üblichen Tariff entsprechend honoriert. Als Dank für das Ausfüllen der Antwortkarte bieten wir Ihnen ein Freiabonnement auf Info-dienst (nur in Deutschland) oder ein kostenloses Exemplar von Teil I von unserem Kursus Digital Instrument.

L'intérêt du "feedback"

Vous voilà possesseur d'un instrument d'essai et de mesure Philips. Nous espérons qu'il vous donnera de nombreuses années de bons et loyaux services, mais nous voudrions attirer votre attention sur un point: ce n'est qu'avec **votre** aide que nous pouvons fournir des matériels d'essai et de mesure de toute première qualité.

Nous avons besoin de savoir quels en sont les points forts et les points faibles que vous avez découverts et nous serions très intéressés d'apprendre quelles applications inhabituelles ou élégantes vous lui avez trouvé. Certains de ces renseignements peuvent être transmis utilement à nos bureaux d'études; certains autres peuvent être communiqués à d'autres utilisateurs par l'intermédiaire de notre publication **T & M News** (édition française seulement en France).

C'est pourquoi nous vous serions reconnaissants de remplir la carte-réponse à côté et de nous la renvoyer (ou, mieux encore, de noter dans votre agenda que vous devez remplir la carte-réponse dans, mettons, six mois, une fois que vous aurez acquis quelque expérience pratique de l'utilisation de l'instrument). De cette façon, vous contriburez à nous fournir le "feedback" dont nous avons besoin pour mieux vous servir!

Toutes les réponses publiées seront payées conformément aux tarifs en vigueur; pour vous inciter à remplir la carte-réponse, nous offrons un abonnement gratuit à T & M News ou un exemplaire gratuit de la première partie de notre cours sur les instruments numériques à tous ceux qui répondront.

Details of user: **Persönliche Angaben:** **Expéditeur:**

Company/
Firma/Société .....
Department/
Abteilung/Service .....
Street/Straße/Rue .....
Box/Postfach/Boîte Postale .....
City/Stadt/Ville .....
Country/Land/Pays .....
Name/Name/Nom .....
Phone/Telefon/Numéro de téléphone .....

Details of instruments: **Gerätedaten:** **Instrument:**

Name/Name/
Désignation .....
Type number/Typennummer/
Numéro de type .....
Serial number/Seriennummer/
Numéro de série .....
Date purchased/Kaufdatum/
Date d'achat .....

What are the main applications for which you use this instrument?
Wofür verwenden Sie dieses Gerät hauptsächlich?
Quelles sont les principales utilisations auxquelles vous affectez cet instrument?

.....
.....

Please, list what you consider to be the **strong points** and the **weak points** of the instrument.
Zählen Sie bitte auf, was Ihrer Meinung nach die **guten Seiten** und was die **schwachen Stellen** dieses Geräts sind.
Veuillez énumérer ce que vous considérez être les **points forts** et les **points faibles** de l'instrument.

.....
.....
.....

Do you have any queries about the use of this instrument? If so, what?
Haben Sie irgendwelche Fragen über die Anwendung dieses Geräts? Wenn ja, welche?
Avez-vous des questions à poser sur l'emploi de l'instrument? Si oui, lesquelles?

.....
.....
.....

I have devised an interesting application for this instrument.

- ☐ I enclose a brief description (up to about 500 words) of this application
- ☐ Please, send a representative to collect information about the application

Ich habe einen interessanten Verwendungszweck für dieses Gerät gefunden.

- ☐ Eine kurze Beschreibung hiervon (max. ca. 500 Wörter) erhalten Sie anliegend.
- ☐ Senden Sie bitte jemanden, der sich an Ort und Stelle über den Verwendungszweck informieren kann.

J'ai trouvé une application intéressante pour cet instrument

- ☐ Je joins une brève description (500 mots environ au maximum) de cette application.
- ☐ Veuillez envoyer un représentant à qui nous donnerons des renseignements sur l'application.
- ☐ I would like to receive **T & M News** regularly.
- ☐ Please send me Digital Instrument Course Part I.
- ☐ Ich möchte Info-dienst regelmäßig beziehen.
- ☐ Senden Sie mir Digital Instrument Course, Teil I.
- ☐ J'aimerai recevoir **T & M News** régulièrement.
- ☐ Envoyez moi la première partie du cours sur les instruments numériques.

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T & M News
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S & I TQ III - 2
Test and Measuring Instruments Department
Att. Mr. T. Sudar
EINDHOVEN
The Netherlands

please fold

T & M News is your feedback unit

T & M News is a bimonthly publication issued by the Test & Measuring Department of Philips' Science & Industry Division, for distribution to actual and potential users of Philips' T & M equipment. It provides an effective means of exchanging information in the T & M field - both from the manufacturer to the customer and **vice versa.**

Apart from T & M **News itself,** we also issue **T & M News Supplement,** (only in English) which provide a vehicle for (generally longer) articles of a more specialized and/or theoretical nature to supplement the information given in **T & M News.** These supplements, being of a more specialized interest, are generally send to a more restricted group of users; though anyone who is interested can obtain them on request.

One special series that just appeared in T & M News Supplements was our Digital Instrument Course (Part I: Basic binary theory and logic circuits; Part II: Digital counters and timers; Part III: Digital voltmeters and multimeters), which proved so popular with readers that each part of the course has been re-issued in booklet form (only in English).

Info-dienst für Ihren Erfahrungsaustausch

Info-dienst (nur in Deutschland) ist eine Publikation der Philips GmbH Unternehmensbereich für Elektronik für Wissenschaft und Industrie für die jetzigen Besitzer und potentiellen Kunden von Philips T & M-Geräten. Dieses Blatt strebt einen effektieven Informationsaustausch auf dem T & M-Gebiet zwischen Hersteller und Anwender sowie **umgekehrt** an.

Neben diesen Info-dienst geben wir auch die **T & M News Supplements** heraus (nur in englischer Sprache), in denen (im allgemeinen längere) Artikel mehr spezieller bzw. theoretischer Art als Ergänzung zu den Informationen in Info-dienst stehen. Diese Supplements, an denen in allgemeinen nur Spezialisten interessiert sind, werden an eine begrenzte Anwendergruppe verteilt. Jeder, der daran interessiert ist, kann sie auf Anfrage erhalten.

Eine spezielle Serie, die gerade in den T & M News Supplements erschienen ist, war unser Digital Instrument Course (Teil I: Basic binary theory and logic circuits; Teil II: Digital counters and timers; Teil III: Digital voltmeters and multimeters). Diese Serie war bei den Lesern so populär, daß jeder Teil von diesem Kursus auch in Buchform herausgegeben wurde (nur in englischer Sprache).

T & M News est notre moyen de communiquer mutuellement

T & M News est une publication de département de Mesure de Philips, destinée aux utilisateurs effectifs et un puissance d'appareils d'essai et de mesure Philips. Elle constitue un moyen efficace de transmettre de l'information dans ce domaine, aussi bien du fabricant vers le client que **vice versa.**

A part la publication **T & M News proprement dite,** nous diffusons les **T & M News Supplements** (seulement en anglais) qui contiennent des articles (généralement plus longs) de nature plus spécialisée ou plus théorique, destinés à compléter l'information donnée dans **T & M News.** Etant donné leur nature, ces suppléments ne sont généralement envoyés qu'à un cercle plus restreint d'utilisateurs; toutefois, quiconque s'y intéresse peut les obtenir sur demande.

Nous venons de publier dans les T & M News Supplements une série spéciale d'articles qui constituent un cours sur les instruments numériques (1ère partie: Théorie binaire de base et circuits logiques; 2ème partie: Compteurs numériques et minuteries; 3ème partie: voltmètres et multimètres numériques) qui a rencontré un tel succès auprès des lecteurs que chaque partie du cours a été réimprimée sous forme de livret (seulement en anglais).

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Operating manual

1. GENERAL INFORMATION

1.1. INTRODUCTION

The PM 3266 is a portable storage oscilloscope with a very high writing speed (1000 DIV/μs). The instrument enables the measurement of signals at a high sensitivity (2 mV/DIV) over an extensive bandwidth (100 MHz). The oscilloscope has been designed using a large number of integrated circuits, which guarantee very stable operation and reduce the number of adjusting points. As an aid to checking and adjusting, test points have been included at appropriate positions around the circuit. The instrument features various storage functions such as normal and fast writing speed and auto erasure.

There is a wide choice of display possibilities, such as one channel, two channels alternately or chopped, two channels added with normal and inverted positions for both input signals, and a main and delayed time-base. Additional features of the PM 3266 are the 3rd channel TRIG VIEW and ALTernate TB facilities.
TRIG VIEW enables the display of the trigger signal (internal or external applied) via a 3rd channel by push-button selection.
ALT.TB offers the instrument user a simultaneous display of the signal on the two time scale provided by the main time-base and the delayed time-base.
The PM 3266 oscilloscope features a tapless power supply that covers two voltage ranges, 90 V to 140 V and 200 V to 264 V by means of a switch, thus obviating the need for continuous adjustment to the local mains voltage.
All these features make the oscilloscope suitable for a wide range of applications.

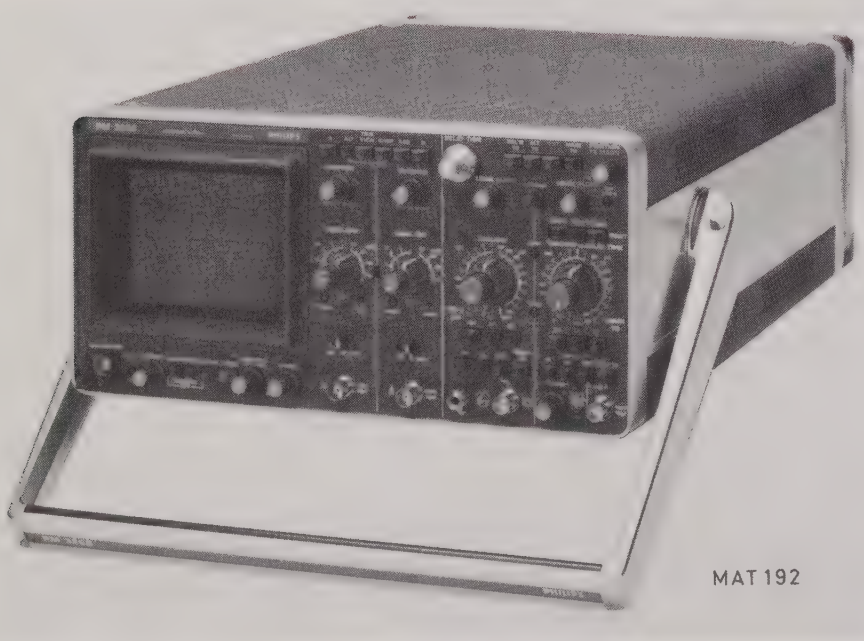


Fig. 1.1. Portable dual-trace Storage oscilloscope PM 3266

1.2. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class 1 instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings that shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

This specification is valid after the instrument has warmed up for 30 minutes.
Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.
Numerical values without tolerances are typical and represent the characteristics of an average instrument.

1.2.1. CRT section

Designation	*Specification*	*Additional information*
CRT type	PHILIPS L14-140GH/95	Storage tube with high writing speed, image transfer and scan magnification in vertical direction. Rectangular tube face, post accelerator and metal-backed phosphor.
Useful screen area	8 x 10 DIV	1 DIV equals 0,9 cm. Vertical and horizontal straight lines shall be presented as straight lines on the c.r.t. in the central 7 x 9 DIV screen area.
Screen type	P31 (GH) phosphor	
Total acceleration voltage	10 kV	
Graticule	Internal	Non-illuminated
Engravings	Dotted lines at 1, 5 and 6,5 DIV from top of display provide measuring lattice for checking of rise-time	
Writing speed	1000 DIV/μs	In FAST mode. Not guaranteed for the square areas of 2 by 2 divisions in each screen corner
	2,5 DIV/μs	In WRITE mode and MAX position
	0,25 DIV/μs	In WRITE mode
Storage time	1 hour max.	In STORE mode: dependent on the position of the INTENS (brightness) control
	60 sec.	In the WRITE mode at max. intensity
	15 sec.	In the MAX WRITE mode at max. intensity
	15 sec.	In the FAST mode at max. intensity.
Persistence	0,3 sec ... 1 min	Operative in WRITE MODE. Continuously variable.
Auto Erase	Operative in Fast mode with VIEW TIME control out of the MAX position. View time continuously variable between 3 and 8 sec.	In the auto-erase mode the following cycle occurs: the stored picture is erased. If the time-base is triggered a new picture is written. After the adjusted view time another cycle starts and the picture is erased, etc. In the FAST mode the AUTO, TRIG and SINGLE pushbuttons are inoperative. Their function is taken over by the storage unit.
Erase time	1,3 sec. in WRITE mode 1,6 sec. in FAST mode	These values represent the time between the release of the ERASE button and the end of the erase cycle. The erase button resets the main time-base.
Trace rotation	Screw-driver adjustment point	Accessible via one of the ventilation holes on the left-hand side of the instrument

	Designation	*Specification*	*Additional Information*
1.2.2.	**Vertical or Y axis**		
1.2.2.1.	*Response (2mV range excepted)*	For 2 mV spec. see 1.2.2. 13.	35 MHz at 2 mV
	Frequency range	d.c. to 100 MHz a.c. 7 Hz to 100 MHz	–3 dB bandwidth d.c. coupled –3 dB bandwidth a.c.coupled frequency range includes 10:1 probe over 20-30 °C
	Rise-time	3,5 ns	
	Pulse aberrations	± 4% peak-peak	Over 6 divisions, +5 – 40°C
1.2.2.2.	*Deflection coefficient*	2 mV/div ... 5 V/div	(for 2 mV spec. refer to Section 1.2.2. 13.) Eleven calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : 2,5. Uncal. lamp signalling.
	Error limit	± 3%	Except linearity of CRT.
	Maximum permissible input voltage	± 400 V	d.c. + a.c. peak. Derating at frequencies above 500 kHz. See Fig. 1.2.
	Maximum undistorted deflection	24 divisions	Up to 35 MHz
	Shift range	16 divisions	8 divisions each in upward and downward direction from the central horizontal line of graticule.
1.2.2.3.	*Input impedance*	1 M Ω (± 2 %) // ≈ 15 pF	
	Input RC time	22 ms	Coupling to AC
1.2.2.4.	*Instability*		(for 2 mV/DIV setting refer to 1.2.2.13.).
	Instability of trace	0,1 div/hour	20-40 °C temperature range
	Trace jump	0,2 div	When switching between any of the attenuator positions
	Trace jump	0,5 div	When operating the NORM/INVERT switch
	Trace shift	0,2 div	When rotating the continuous attenuator 0,4 div in 5 mV setting
	Trace shift	1 div	When switching to the ADDED position. 0,4 div in 5 mV setting. Increasing when rotating the continuous attenuator.
1.2.2.5.	*Short-term temperature drift*	As 1.2.2.6.	
1.2.2.6.	*Long-term temperature drift*	20 μV/°C	Typical value
1.2.2.7.	*Visible signal delay*	15 ns approx.	
1.2.2.8.	*Display modes*	Channel + or – A only Channel + or – B only Trig. view only Channels ± A and ± B chopped Channels ± A and ± B alternated Channels ± A and ± B added ± A, ± B and Trig. view chopped or alternated (3 channels display)	If 3 channels display is selected in combination with alternate time-base display, this will be automatically displayed in main time-base intensified mode. Refer to 1.2.2.12. for full trig. view specification.

	Designation	*Specification*	*Additional Information*
1.2.2.9.	*Chopper frequency*	≈ 1 MHz	Display time per channel 350 ns approx.
1.2.2.10.	*Cross-talk between channels*	1:500	Up to 50 MHz With 8 divisions of signal amplitude on one channel, cross talk on other channel within line width, up to 35 Mc. Both attenuators in the same setting.
1.2.2.11.	*Common mode rejection factor*	Better than 100 up to 2 MHz 20 at 50 MHz	Measured with +A and −B added. Max. common-mode signal 8 divisions.
1.2.2.12.	*Trigger view display*	External or internal trigger signal.	
	Deflection coeff.	Same as vertical	
	External	100 mV/div ± 3 %	
	External ÷ 10	1 V/div ± 5 %	
	Internal	Vertical ± 10 %	
	Trigger point (threshold)	Screen centre ± 0,3 div	Coupling d.c.
	Aberrations	± 10 % peak-to-peak	
	Time delay between vertical input and external input	3 ns ± 1 ns	
	Bandwidth	80 MHz	Typical value
1.2.2.13.	*Specification of 2 mV/div setting*		
	a. Deflection coeff.	2 mV/div	
	Error limit	± 5 %	
	b. Response		
	Frequency range	DC 0 ... 35 MHz AC 7 Hz ... 35 MHz	−3 dB −3 dB
	Rise time	10 ns	
	Pulse aberration	± 5 % peak-to-peak	
	Common mode rejection factor	Better than 100 up to 2 MHz	
	c. Instability		
	Instability of trace	0,25 div/hour	20-40 °C temperature range
	Trace jump	1 div	When switching from 5 mV to 2 mV attenuator position
	Trace jump	2 div	When operating the Normal/Invert switch
	Trace shift	1 div	When rotating the continuous attenuator
	Trace shift	1 div	When switching to ADDED position

	Designation	*Specification*	*Additional Information*
1.2.3.	**Horizontal or X Axis**		
1.2.3.1.	*Display modes*	– Main time-base – Main time-base intensified by delayed time-base – Delayed time-base – Main TB intensified and delayed TB alternately displayed. – X-Y and X-Y/Y operation	With possibility of trace separation of 4 divisions. X deflection by: – channel A signal – channel B signal – signal applied to EXT connector of main TB – line voltage
1.2.3.2.	*Horizontal position drift in X1 position*	0,2 div/hour	The horizontal position drift with the magnifier in the X1 position, shall not exceed 0,1 div/hour over 20-40 °C temperature range. The same stability requirement applies to the start of the sweep during variation of the sweep speed setting, with exception of highest sweep ranges (50-100 ns/div).
1.2.3.3.	*Horizontal position control*	± 5,2 div from screen centre	The horizontal shift control combines coarse and fine adjustment.
1.2.4.	**Main Time-base**		
1.2.4.1.	*Operation*	Automatic Triggered and single shot	Automatic free running in the absence of triggering signals, after less than 0,1 sec.
1.2.4.2.	*Time coefficient*	1 s/div ... 50 ns/div	23 calibrated positions in a 1-2-5 sequence Uncalibrated continuous control 1:>2,5 between the steps. One uncal. lamp for both MTB and DTB.
1.2.4.3.	*Coefficient error* The difference in sweep accuracy over any two div.	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C The difference in sweep accuracy over any two divisions of 10 div sweep is ± 5 %, excluding the first and last div at the 5 ns and 10 ns magnified sweep rates.

	Designation	*Specification*	*Additional Information*
1.2.4.4.	*Expansion*		
	Magnification	10x	Switched, calibrated. The display when coinciding with the central horizontal graticule line shall not shift more than one div when the horizontal magnifier is changed from X1 to X10.
	Coefficient error	± 1 % additional	First and last 50 ns of 5 ns/div, 10 ns/div and 20 ns/div magnified sweep rates ± 5 %.
	Max. effective time coefficient	5 ns/div	
1.2.4.5.	*Variable hold-off time*	The sweep hold-off time can be increased by a factor of 10.	
1.2.5.	**Delayed Time base**		
1.2.5.1.	*Operation*	Delayed time-base starts optionally either immediately after the delay time, or upon arrival of the first trigger pulse after the delay time.	
1.2.5.2.	*Comparator long-term stability*	< 2 div at 1000 times magnification	With MTB at 1 ms/div and DTB at 1 µs/div a selected signal detail in the DTB mode shall not move more than two divisions after warm-up
1.2.5.3.	*Time coefficient*	0,5 s/div ... 50 ns/div	22 calibrated positions in 1-2-5 sequence Uncalibrated continuous control 1:2,5 between the steps. One uncal. lamp for both MTB and DTB.
1.2.5.4.	*Coefficient error*	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C The difference in sweep accuracy over any two divisions of 10 div sweep is ± 5 %, excluding the first and last div at the 5 ns and 10 ns magnified sweep rates.

	Designation	*Specification*	*Additional Information*
1.2.5.5.	*Delay-time*	Continuously variable between 0x and 10x the time coefficient of the MTB	Calibrated. Range delay-time multiplier 0,00-9,99 Incremental accuracy 0,5 % typical 0,2 %.
1.2.5.6.	*Delay-time jitter*	1:20.000	
1.2.6.	**X Deflection**		
	X deflection via channel Y_A or Y_B	2 mV/div ... 5 V/div	Uncalibrated continuous control 1:2,5 via Y gain potentiometer.
1.2.6.1.	*Coefficient error*	± 5 %	
1.2.6.2.	*Bandwidth*	0 - 2 MHz	–3 dB bandwidth over 4 div.
1.2.6.3.	*Maximum undistorted delfection*	20 divisions	up to 100 kHz
1.2.6.4.	*Phase difference with respect to Y display*	3^o at 100 kHz	
	External X-deflection via EXT socket		
1.2.6.5.	*Deflection coefficient*		
	External External ÷ 10	50 mV/div 500 mV/div	Uncalibrated continuous control 1:3
1.2.6.6.	*Accuracy*		
	External	± 3 %	Additional 2 % for Ext. :10
1.2.6.7.	*Bandwidth*	d.c. ... 2 MHz 7 Hz ... 2 MHz	Via DC trigg. coupling via LF or HF trigg. coupling
1.2.6.8.	*Input characteristics*	Identical to Y channels	
1.2.6.9.	*Phase difference Y-channels*	3^o at 100 kHz	
1.2.6.10.	*Linearity*	1,5 %	
1.2.6.11.	*Drift*	0,2 div./hr.	
1.2.7.	**Triggering of the main time-base**		
1.2.7.1.	*Trigger source*	Internal from channel A Internal from channel B Composite A and B Internal from line External source External source ÷ 10	Alternate vertical mode only
1.2.7.2.	*Trigger modes*	Automatic	Automatic free-run of the time-base generator approx. 100 ms after disappearance of the trigger signal.
		Trigg. and single sweep	NOT TRIG'd lamp is illuminated after reset and extinguishes at the end of the sweep.
1.2.7.3.	*Slope*	+ or –	

	Designation	*Specification*	*Additional Information*
1.2.7.4.	*Trigger sensitivity*	Internal:0,5 div. upto 1,5 div. at 100 MHz	Typical sensitivity as a function of frequency. see Fig. 1.3.
		External: 50 mV upto 150 mV at 100 MHz	Typical sensitivity as a function of frequency, see Fig. 1.3.
		External÷ 10 : 500 mV	
1.2.7.5.	*Trigger modes and coupling*	DC: 0 - full bandwidth LF int: 0 - 30 kHz LF ext: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz AUTO: 20 Hz - full bandwidth	Both internal and external –3 dB –3 dB –3 dB, both internal and external
1.2.7.6.	*Level range*		
	internal trigg. external trigg. external :10	24 DIV +1,2 V to –1,2 V +12 V to –12 V	
1.2.7.7.	*Input characteristics*	1MΩ (± 2%) //≈ 15pF	
1.2.7.8.	*Trigger jitter*	Better than 0,5 ns	
1.2.8.	**Triggering of the delayed time-base**		
1.2.8.1.	*Source*	Internal from channel A Internal from channel B External	Other characteristics are identical to TRIGGERING OF THE MAIN-TIME BASE. Except Ext. :10 and line trigg.
1.2.9.	**Calibration unit**		
1.2.9.1.	*Output voltage*	3 $V_{p\text{-}p}$	
1.2.9.2.	*Output current*	6 mA	
1.2.9.3.	*Error limit*	± 1 %	Both voltage and current
1.2.9.4.	*Frequency*	2 kHz ± 2 %	
1.2.9.5.	*Protection*	The output is protected against continuous short-circuiting.	
1.2.10.	**Additional Input and Outputs**		
1.2.10.1.	*Z-modulation*	DC coupled TTL compatible Positive polarity Blanks display response time 35 ns input impedance 10 kΩ max. input voltage 50 V	
1.2.10.2.	*Main TB Gate*	0 ... +5 V delivered during MTB sweep	Optionally available Output impedance 1 KOhm.
1.2.10.3.	*Delayed TB Gate*	0 ... +5 V delivered during DTB sweep	Optionally available Output impedance 1 KOhm

	Designation	*Specification*	*Additional Information*
1.2.11.	**Power supply**		
1.2.11.1.	*Line voltage*	90...140 Va.c. 200...264 Va.c. 250...350 Vd.c.	Automatically protected against incorrect setting of line selector
1.2.11.2.	*Line frequency*	46 to 440 Hz	
1.2.11.3.	*Power consumption*	50 W	
1.2.11.4.	*Power transients*		Damage to the oscilloscope shall not occur under voltage and frequency transient conditions specified in MIL-T-28800.

1.2.12. Environmental characteristics

Note:

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

1.2.12.1. Temperature tests

In accordance with IEC 68 Ab and Bb.
Operation: −15 °C to +55 °C.
Operation within specification: +5 °C to +40 °C. Exceptions on tolerances to be indicated per spec. point.
Storage: −55 °C to +75 °C.

1.2.12.2. Altitude

In accordance with IEC 68-2-13 test M.
Operation: to 15.000 feet (5000 m)
Derating: 1 °C/1000 feet for the max. operating temperature
Storage: to 50.000 feet (17.000 m)

1.2.12.3. Shock

Operating: 30 g, half-sine, 11 ms duration, 2 shocks per axis per direction for a total of 12 shocks.

1.2.12.4. Vibration

Operating: 15 minutes along each of 3 axes.
0.025 inch p-p displacement (4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles.

1.2.12.5. Recovery

Operates within 30 minutes coming from −10 °C soak, going into room condition of 60 % R.H. at 20 °C

1.2.12.6. Magnetic Shielding

In accordance with IEC 351 - 22.3.1.
A maximum deviation of 1 div.

1.2.12.7. Interference

VDE 0871 and 0875, störgrad K

1.2.13. Mechanical data

1.2.13.1.	*Dimensions*	Length 460 mm (16 1/4 in.) Width 316 mm (12 1/4 in.) Height 154 mm (6 1/8 in.)	Excluding controls, cover and feet
1.2.13.2.	*Weight*	10.9 kg (21 lbs)	

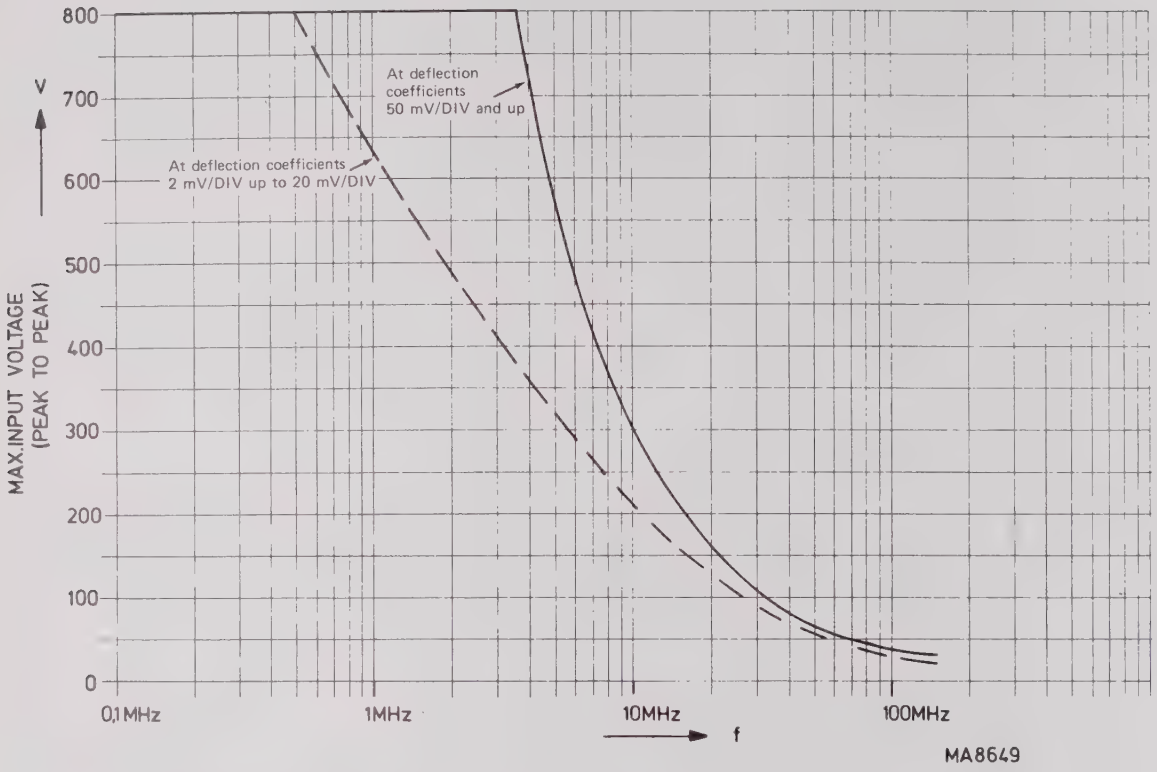


Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency

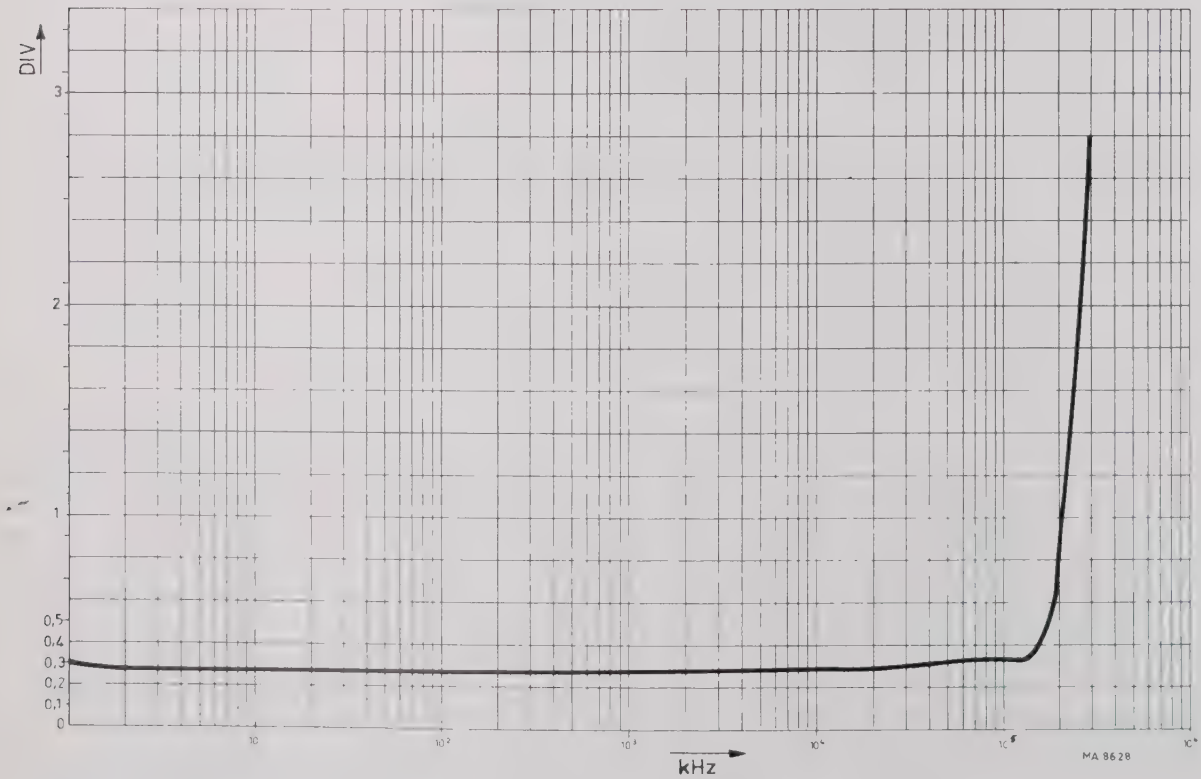


Fig. 1.3. Typical trigger sensitivity of channel A as a function of frequency

1.3. ACCESSORIES

1.3.1. Accessoires delivered with the instrument

- Two passive 10:1 probes
- Contrast filter
- Front cover with storage space
- Collapsible viewing hood (PM 9366)
- Banana - BNC adapter (PM 9051)
- CAL terminal - BNC adapter
- Manual

1.3.2. Optional accessoires

PM 8921	Passive probe set 1 : 1 (1.5 m)
PM 8921L	Passive probe set 1 : 1 (2.5 m)
PM 8935	HF passive probe set 10 : 1 (1.5 m)
PM 8935L	HF passive probe set 10 : 1 (2.5 m)
PM 8932	Passive probe set 100 : 1
PM 8994	Set of accessories for probes
PM 9353	Active FET probe 1 : 1; 10 : 1; 100 : 1; 3.5 pF (1.5 m)
PM 9355	Current probe: 1 mA/div ... 1 A/div.; 12 Hz ... 70 MHz
PM 9346	Power supply for active probes
PM 8960	19 inch rack mount adaptor
PM 8992	Accessory pouch
PM 9380	Oscilloscope camera
PM 8971	Adapter for oscilloscope camera
PM 8910	Polaroid anti-glare filter
PM 8980	Long type viewing hood
PM 8901	Battery pack 24 V d.c. and 280 V d.c.
PM 8991	Oscilloscope trolley
800/NTX	Trimming tool kit

Steinheil Oscillophot ® system: Oscilloscope camera's M3, M4 and M5 can be mounted on oscilloscope using Steinheil adapter 1820/50.

Fig. 2.1. Removing Front Cover

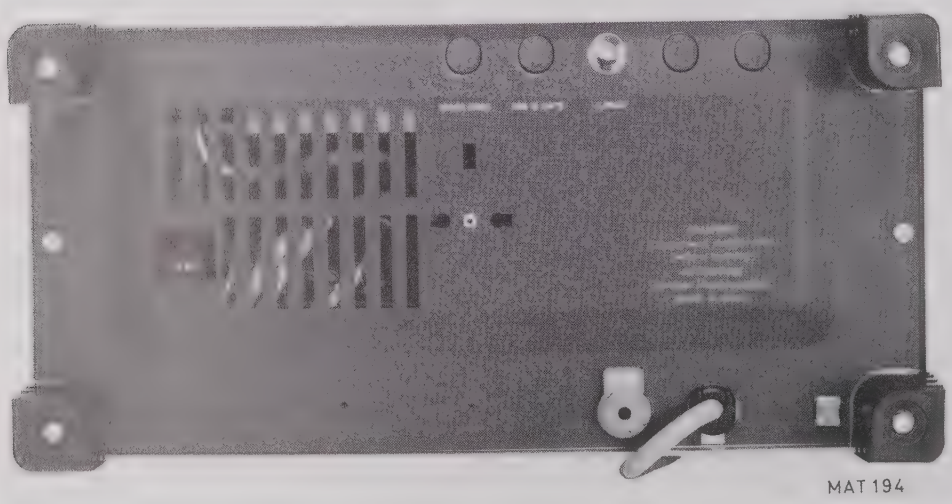


Fig. 2.2. Rear view of the instrument

2. Operating manual

2.1. GENERAL INFORMATION

This section outlines the procedures and precautions necessary for installing the PM 3266, identifies and briefly describes the functions of the front and rear panel controls and indicators, and explains the practical aspects of operation to enable an operator to evaluate quickly the instrument's main functions.

2.1.1. Installation

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section EARTHING).

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals, which can be dangerous to life.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair is effected with the instrument open. If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved. Bear in mind that the capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

2.1.2. Removing and fitting the front cover (see Fig. 2.1.)

Removing:
- Rotate the knob in the centre of the cover a quarter-turn anti-clockwise to UNLOCKED position.
- Remove the cover

Fitting:
- Rotate the knob to the UNLOCKED position
- Fit the cover over the front of the oscilloscope.
- Press and rotate the knob a quarter-turn clock-wise to LOCKED position.

Note: The handle can be rotated if the push-buttons on its bearings are depressed.

2.1.3. Mains adjustment and fuse

The ability of the instrument to operate at any mains voltage between 90 V and 140 V (with mentioned voltage rate on CIRCUIT BREAKER visible) and between 200 V and 264 V (link reversed) (also visible through the window at the rear), obviates the need to adapt the instrument to the local mains, once the relevant supply range has been established.

The fuse-holder, which is mounted on the rear panel, carries a 2 A delayed action fuse. Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse-holders shall be avoided. This instrument shall be disconnected from all voltage sources when a fuse is to be replaced.

Note: For the setting 90 V ... 140 V as well as the setting 200 ... 264 V the same 2 A delayed action fuse is used.

2.1.4. Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- via the protective earth terminal at the rear (identified by the symbol ⏚);
- via the earth wire in three-core mains cable.

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor. Replacing the mains plug is at the user's own risk.

WARNING: Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal is likely to render the instrument dangerous. Intentional interruption is prohibited.
When an instrument is brought from a cold to a warm environment, condensation may cause a hazardous condition. Ensure, therefore, that the earthing requirements are strictly adhered to.

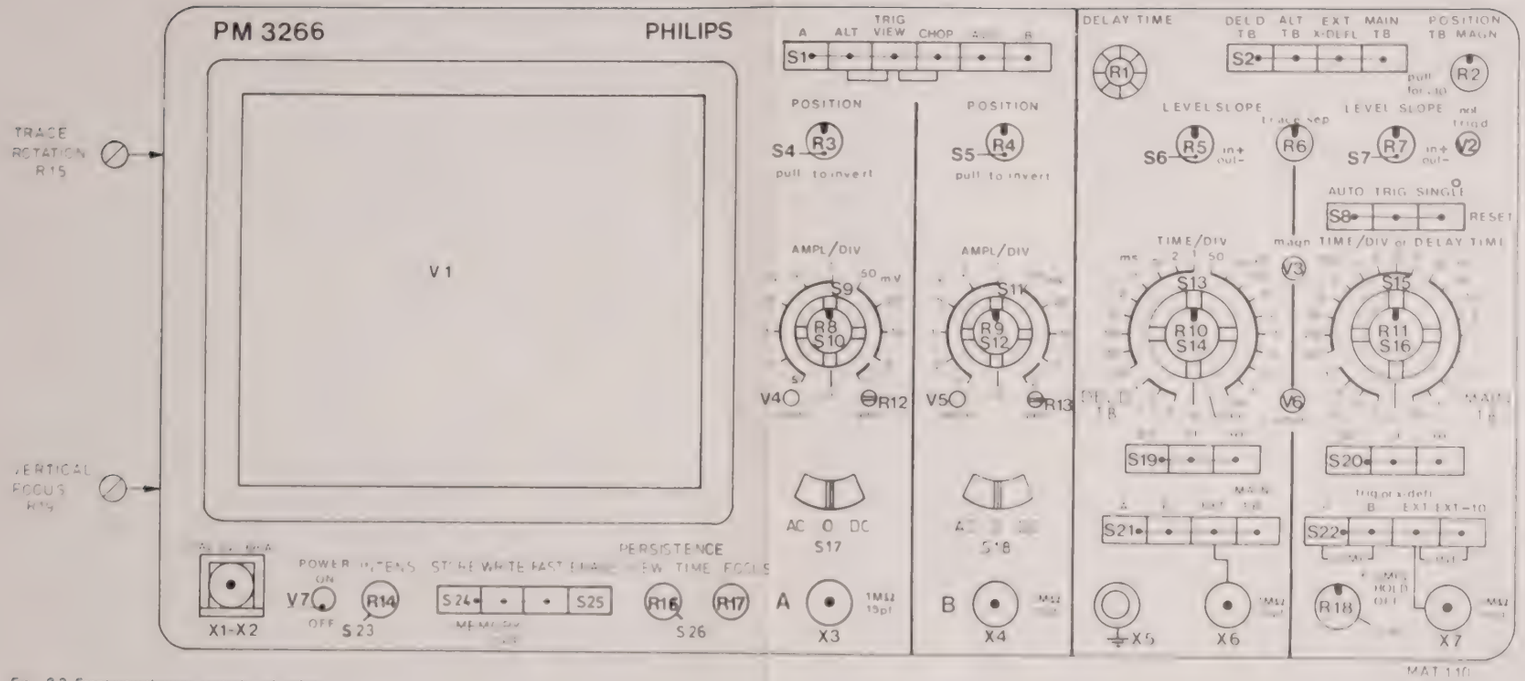


Fig. 2.3. Front view showing controls and sockets
Abb. 2.3. Vorderansicht mit Bedienungsorganen und Buchsen
Fig. 2.3. Vue avant montrant les commandes et douilles

2.1.5. Switching on

The POWER switch is incorporated in the [illegible]
screen bezel. The associated POWER ON LED [illegible]
The oscilloscope must never be switched on wi[illegible]
Never remove a mains fuse unless the [illegible]

2.2. OPERATING INSTRUCTIONS

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with section 2.1. INSTALLATION and that the precautions outlined have been observed.

2.2.1. **Controls and sockets** (Fig. 2.3.)

2.2.1.1. Vertical channels

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Vertical display-mode controls; 6-way push-button switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal; i.e. the A and B channels are displayed on ALTernate sweeps.
TRIG VIEW depressed	The display is switched to view the selected trigger signal. Trigger view display can be internal via A or B channels (A or B of S22 depressed) or external via external input socket X7, when EXT or EXT ÷ 10 of S22 is depressed.
CHOP depressed	The display is switched over from one vertical channel to the other at a fixed frequency, both A and B channels being displayed during the same sweep.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B.
All pushbuttons normal	If no push-button is depressed, the instrument operates in the ALT mode.
ALT and TRIG VIEW depressed simultanuously	The signals on channels A, B and TRIG VIEW are displayed during alternate sweeps; usually suitable for high frequency signals (see also explanation of push-button TRIG VIEW)
CHOP and TRIG VIEW depressed simultaneously	The signals on channel A, B and TRIG VIEW are displayed one after the other at the CHOP frequency during the same sweep; usually suitable for low frequency signals. (See also explanation of push-button TRIG VIEW)
POSITION (R3, R4)	Continuously variable control giving vertical shift of the display.
PULL TO INVERT (S4, S5)	2-way push-pull switch, integral with the POSITION control, for the inversion of the signal polarity. Control is depressed for NORMAL and pulled for INVERT.
AMPL/DIV (S9, S11)	Step control of the vertical deflection coefficients; 11-way switch.
CAL (AMPL/DIV) (R8/S10, R9/S12)	Continuously variable control of the vertical deflection coefficients. In the CAL position the selected deflection coefficient is calibrated
UNCAL (V4, V5)	Pilot lamp indicating that the CAL control is not in the CAL position.
GAIN (R12, R13) (screw-driver control)	Continuously variable preset control of the overall gain of the vertical channels.

AC, 0, DC (S17, S18) — Signal input coupling; 3-way switch

AC position — Coupling via a blocking capacitor

0 position — Connection between input circuit and input socket is interrupted and the amplifier input is earthed to establish a reference.

DC position — Direct coupling

With no button depressed, the circuit operates effectively as if the AC button is depressed,
When viewing long duration pulses or d.c. levels of waveforms, the DC position should be selected. For a.c. waveforms with large d.c. levels, the AC position should be selected.

A, 1 MΩ//15 pF (X3) — BNC input socket for channel A.

B, 1 MΩ//15 pF (X4) — BNC input socket for channel B.

2.2.1.2. Horizontal channels

DEL'D TB, ALT TB, EXT X DEFL, MAIN TB (S2) — Horizontal displaymode or deflection controls; 4-way push-button switch.

DEL'D TB depressed — The horizontal deflection voltage is supplied by the delayed time-base generator.

ALT TB depressed — The horizontal display is switched over from the main time-base to the delayed time-base at the end of every cycle of the main time-base generator.
Not functioning when TRIG VIEW is depressed or when the delayed time-base is switched to OFF.

EXT X DEFL depressed — Horizontal deflection is achieved by a signal applied to the external input socket (X7) of the horizontal amplifier, by the channel A or B signals, the composite signal, or by a mains-frequency (LINE) signal, depending on the TRIG or X DEFL push-button (S22) selection.

MAIN TB depressed — The horizontal deflection voltage is supplied by the main time-base generator.
A part of the trace is intensified (except in the OFF position of the TIME/DIV switch of the delayed time-base generator).
No push-button depressed is effectively the same as MAIN TB depressed.

POSITION TB MAGN (R2, S3) — Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch for increasing the horizontal deflection coefficient by a factor of 10 (PULL FOR X10).

MAGN (V3) — A pilot lamp indicating that the X10 magnifier is in operation.

X-AMPL, HOLD-OFF (R18) — Continuously variable control of the horizontal deflection coefficients when using external X deflection.
In the case of X deflection by the main time-base, this control can be used to increase the sweep hold-off time.

TRACE SEP. (R6); — Continuously variable preset control of the vertical space between the two time-base displays in the ALT TB mode.

2.2.1.3. Main time-base generator

LEVEL-SLOPE (R7, S7) — Continuously variable control for selecting the level of the triggering signal at which the time-base generator starts.
This control incorporates a push-pull switch that enables choice of triggering on either the positive- or negative-going edge of the triggering signal (IN +, OUT −).

NOT TRIG'D (V2) — Pilot lamp indicating that the time-base generator is in the waiting position.

AUTO, TRIG, SINGLE (S8)	Trigger-mode controls; 3-way push-button switch.
AUTO depressed	The main time-base is free-running in the absence of trigger signals.
TRIG depressed	The time-base generator is normally triggered.
SINGLE depressed	After depressing the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse.
	If no button is depressed the circuit operates effectively as if the SINGLE mode has been selected.
TIME/DIV or DELAY TIME (S15)	Time coefficient control of the main time-base; 23-way rotary switch.
CAL (blue) - TIME/DIV (R11, S16)	Continuously variable control of the main time-base coefficients. In the CAL position the time coefficient is calibrated.
UNCAL (V6)	Pilot lamp indicating that the CAL control is not in the calibrated position.
DC, LF, HF (S20)	Trigger coupling; 3-way push-button switch.
DC depressed	Triggering signals are direct-coupled.
LF depressed	Trigger coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 7 Hz to 30 kHz).
HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz. With no push-button depressed, the circuit operates effectively as with the DC button depressed.
TRIG or X-DEFL (S22)	Trigger source or external X deflection selector; 4-way push-button switch. X-deflection only when push-button EXT X DEFL of S2 (horizontal display-mode controls) is depressed.
A depressed	Internal triggering or X deflection signal derived from channel A.
B depressed	Internal triggering or X deflection signal derived from channel B.
COMP (A and B depressed simultaneously)	Internal triggering or X deflection signal derived from channels A and B.
EXT	Triggering on external signal connected to the adjacent 1 M - 15 pF socket (X7). When the EXT X DEFL button of the horizontal deflection controls is depressed, this socket is connected to the input of the horizontal amplifier.
EXT ÷ 10	EXT triggering or X deflection facilities as above, attenuated by a factor of ten.
LINE (EXT and EXT ÷ 10 depressed simultaneously)	Triggering or X deflection signal derived from an internal voltage at mains frequency. If no button is depressed, no mode is selected.
1 MΩ//15 pF (X7)	BNC socket for external triggering or horizontal deflection

2.2.1.4. Delayed time-base generator

DELAY TIME MULTIPLIER (R1)	Continuously variable control of the delay time, operating in conjunction with the TIME/DIV controls of the main time-base generator.
LEVEL-SLOPE (R5, S6)	Continuously variable control for selecting the level of the triggering signal at which the delayed time-base generator starts.

	This control incorporates a push-pull switch that enables choice of triggering on the positive or negative-going edge of the triggering signal (IN +, OUT –).
TIME/DIV (S13)	Time-coefficient control of the delayed time-base; 23-way rotary switch. Incorporates an OFF position whereby the delayed time-base is switched off.
CAL (blue) - TIME/DIV (R10, S14)	Continuously variable control of the delayed time-base generator time coefficients. In the CAL position the time coefficient is calibrated.
UNCAL (V6)	Pilot lamp indicating that the CAL control is not in the calibrated position.
DC, LF, HF (S19)	Trigger coupling; 3-way push-button switch.
DC depressed	Triggering signals are direct-coupled.
LF depressed	Trigger coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 7 Hz to 30 kHz).
HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz.
	With no push-button depressed, the circuit operates effectively as with the DC button depressed.
A, B, EXT, MAIN TB (S21)	Trigger source control and starting point of delayed time-base 4-way push-button switch.
A depressed	Internal triggering signal derived from channel A after delay time.
B depressed	Internal triggering signal derived from channel B after delay time.
EXT depressed	Triggering after delay time on an external signal connected to the adjacent 1 M - 15 pF socket.
MAIN TB depressed	Delayed time-base starts immediately after delay time.
	With no button depressed, the circuit operates effectively as with the channel A button depressed.
1 MΩ//15 pF (X6)	BNC input socket for external triggering signals.

2.2.1.5. CRT display section

INTENS/POWER ON	Mains ON/OFF switch with LED indication if the instrument is switched on. In the (MAX) WRITE, FAST or MEMORY OFF mode: the position of the knob determines the intensity of the waveform that is written on the storage layer of the c.r.t. In the STORE mode: the position of the knob determines the brightness of the reproduced waveform on the c.r.t. screen. If the brightness is increased the storage time decreases.
STORE/WRITE/FAST/ERASE (MEMORY OFF)	Pushbutton switches for the control of the storage system.
STORE	Enables recorded waveform to be stored for a longer time than available with the PERSISTENCE control. The INTENS control is operative.
WRITE	Enables waveform to be recorded at normal writing speed. The PERSISTENCE and INTENS controls are operative.

FAST	Enables waveform to be recorded at high writing speed. The VIEW TIME and INTENS controls are operative.
ERASE	Enables erasure of the waveform that is written on the storage layer of the c.r.t. This control is not effective in the STORE mode.
MEMORY OFF	If the STORE and WRITE pushbuttons are depressed together the memory function of the c.r.t. is switched off.

The instrument functions in the STORE mode in the event of a faulty pushbutton combination being selected.

PERSISTENCE/VIEW TIME	In the WRITE mode, this control enables a variable retention period for the recorded waveform (variable persistence). The MAX position gives an increase of the writing speed by a factor of approx. 10 times; in this position the c.r.t. shows some background illumination. In the FAST mode, automatic erasure followed by the recording of a new picture occurs after a certain time. This time is determined by the position of the VIEW TIME knob. In the MAX position of this knob, recording of a new picture occurs only after the ERASE button has been depressed. In this position the c.r.t. shows some background illumination.
FOCUS	Continuously variable control of the c.r.t. electron beam focusing in the horizontal direction. The vertical focusing is influenced by the INTENSity control. Therefore, the vertical focusing remains well-adjusted over nearly the whole INTENSity range. For the extreme positions of the INTENS control, the vertical focusing potentiometer is adjustable via a ventilation hole in the left-hand side of the instrument. The highest writing speed in the FAST mode is only obtained for optimum focusing of the electron beam.
TRACE ROT (R15);	Preset control for aligning the trace with the graticule line. Screw driver control on left-hand side of the instrument.

2.2.1.6. Miscellaneous

CAL (X1, X2)	Output socket providing a 2 kHz square-wave voltage of 3 Vp-p and a current of 6 mA for calibration purposes
⏚ (X5)	Measuring earth socket.
Z-MOD (X8) at rear side	Input socket for external Z-modulation.

2.2.2. Preliminary settings

As the following settings are identical for both vertical channels, only the procedure for channel A has been indicated.
Unless otherwise stated, the controls occupy the same position as in the previous adjusting procedure.

2.2.2.1. Adjusting the gain

- Operate push-button A of the display-mode controls (S1)
- Operate push-button A of the trigger-mode selector switch (S22)
- Operate push-button AUTO of the trigger-mode controls (S8)
- Operate push-button MAIN TB of the horizontal deflection controls (S2)
- Display the trace by means of the A POSITION control
- Set the INTENSity and FOCUS controls for a sharp, well-defined trace
  The controls not mentioned may occupy any position.
- Set the channel A AC-0-DC switch to DC
- Set the channel A AMPLitude switch to 0.5 V and the continuous control to CALibrated
- Connect the CALibration socket to the A input socket.
- Check that the trace height is exactly 6 divisions.
  If necessary, readjust the GAIN control on the front panel, immediately below the AMPLitude switch.

2.2.3. Inputs A and B and their possibilities

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

2.2.3.1. YT measurements

To display one signal, one of the two vertical channels can be selected by operating either push-button A or push-button B of the vertical display-mode controls.
When push-button ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is operated, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals is clearly visible to the eye.

In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If push-button ADD of the display mode switch is operated, the signal voltages of both vertical channels are added. Depending on the positions of the polarity switches, either the sum or the difference of the input signals is displayed. The ADDED mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADDED position. When the polarity switches of both channels are set to opposite positions, the common mode parts of the signals on sockets A and B will undergo a very slight amplification only, with respect to the differential mode parts.

2.2.3.2. XY measurements

If push-button EXT X DEFL of the horizontal display-mode selection controls and one of the TRIG OR X DEFL controls are operated, the time-base generator are switched off. If for example push button A of S22 is depressed, a signal applied to the vertical A channel is then used for horizontal deflection. The AC/0/DC switch and the step attenuator of channel A remain operative. Horizontal trace shift is possible with the X POSITION control and continuous control of the deflection coefficients with the A AMPL/DIV control.
Vertical channel B may also be used for X deflection.
To this end, the B button of the TRIG OR X DEFL controls is depressed.

It is also possible to use an internal voltage at the mains frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after depressing the relevant push-button of the TRIG OR X DEFL controls. In the EXT and EXT ÷ 10 modes the trace width can be controlled with the X-AMPL/HOLD OFF potentiometer.
With this potentiometer in its CAL position, the deflection coefficient for external signals is 50 mV/DIV.
The external signal can be either d.c. or a.c. coupled (lower frequency limit 7 Hz) by depressing either the DC or the LF push-button of the trigger coupling controls of the main time-base.

2.2.3.3. AC/0/DC switch

The signals under observation are fed to input socket(s) A and/or B and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifier is d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. and l.f. signals. Some pulse drop will occur when l.f. square wave signals are displayed.

The 0 position interrupts the signal and earths the amplifier input for quickly determining the 0 V level.

2.2.4. Triggering

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal in order to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

2.2.4.1. Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged.
In position LF, a 0 Hz (7 Hz for external triggering) to 30 kHz band-pass filter is inserted. This position can be used to reduce interference from noise.
In position HF, a 30 kHz high-pass filter is inserted.
This position can be used to reduce interference from e.g. hum.

2.2.4.2. Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B depressed), the COMPosite A and B signals (buttons A and B simultaneously depressed), an external source (button EXT or EXT ÷ 10 depressed) or from an internal voltage at mains frequency (button EXT and EXT ÷ 10 depressed).
The trigger pulse shaper is a dual controlled multivibrator switched by the output signals of a differential amplifier.
The trigger signal, together with biasing voltages which are adjustable with the LEVEL potentiometer, fed to the inputs of the differential amplifier.
Depending on the LEVEL setting, a certain part of the trigger signal will be amplified by the differential amplifier.
The multivibrator is thus switched at a fixed point of the trigger signal (see Fig. 2.4.). This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal (in case of internal triggering A or B equal to the shape of the signal to be displayed) and, thus, to choose the point where the multivibrator will be switched.
The LEVEL potentiometer is fitted with a push-pull switch which allows selection of the trigger slope.

2.2.4.3. Automatic triggering

When the AUTOmatic button of the AUTO-TRIG-SINGLE switch is operated, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower than 10 Hz or pulse trains with an off time exceeding 100 ms.
As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again as described in sections 2.2.4.1. and 2.2.4.2.
When the TRIGgered or SINGLE button is operated, the auto-circuit is switched off. The LEVEL setting can also be used in the AUTOmatic mode.

2.2.4.4. SINGLE sweep triggering

When effects which occur only once have to be observed (usually photographed), it is often desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sawtooth in question must be triggered by a trigger pulse. To this end, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been

released will start the time-base generator.
The time-base generator is then blocked until the SINGLE button is pressed again. The NOT TRIG'D lamp will light up as soon as the SINGLE button is depressed and remains lighting until the trigger pulse arrives.

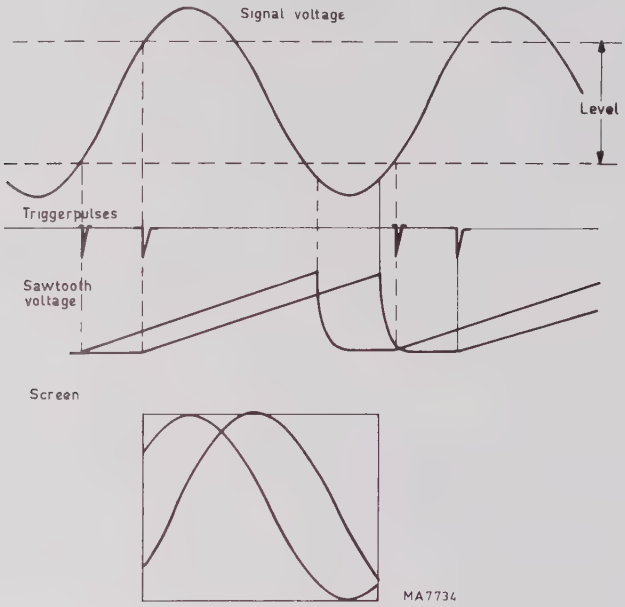


Fig. 2.4. Scanning the waveform by means of the LEVEL potentiometer

2.2.5. Time-base magnifier (R2/S3)

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal-POSITION control If this switch is pulled to position x10, the sweep speed of the main time-base generator is increased by a factor of 10. Thus, the portion of the signal displayed over a width equal to one division in the centre of the screen in the x1 position (TB MAGNifier depressed), will occupy the full width of the screen in the x10 position.
Any portion of the trace can be brought on to the screen by the horizontal-POSITION control for scrutinisation. In the x10 position, the time coeffcient is determined by dividing the indicated TIME/DIV value by 10.

2.2.6. Use of the delayed time-base

The delayed time-base can be used for the accurate study of complex signals. When push-button MAIN TB of the delayed t.b. trigger-source controls (S21) is operated, immediately the delayed time-base is on (i.e. the TIME/DIV switch is not at OFF), a portion of the displayed signal is intensified in the MAIN TB position of the horizontal deflection controls (S2). The DELAY TIME control (R1) enables this intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time-base generator. When push-button DEL'D TB of the horizontal deflection controls (S2) is operated, the intensified portion occupies the full width of the screen. In the DEL'D TB position, the delay time, (i.e. the interval between the starting point of the main time-base and the starting point of the delayed time-base) is determined by the settings of the main TIME/DIV controls and the DELAY TIME control.

If one of the other del'd t.b. trigger-source controls (S21) is operated, the delayed time-base is started by the first trigger pulse that occurs after the selected delay time. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme magnification, originate in the time-base circuits.

2.2.7. Use of the alternate time-base (S2)

The PM 3266 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time-base and by the delayed time-base.
Detailed examination of a certain portion of the main time-base display is enabled by expanding the time interval of interest by means of the delayed time-base. Expansion is achieved by selecting a correspondingly faster sweep for the delayed time-base TIME/div. control. Positioning of the time interval is set by the DELAY TIME potentiometer.

The part of the signal under detailed observation by the delayed time-base remains as an intensified portion of the main time-base display. This not only facilitates the location of the required detail during dialling but also serves as a visual indication of which portion of the overall trace is being examined. One can immediately correlate the detail with the overall signal, which may be extremely complex, without the necessity of switching between MAIN TB and DEL'D TB.

Vertical shift between the two time-base displays is continuously variable with the TRACE SEParation control (R6).

2.2.8. Use of the 3rd channel trigger view

2.2.8.1. External or Internal triggering

In many applications such as triggering with digital signals or signals of widely differing forms, it is necessary to use an external trigger source to ensure proper timing relationships and to know the time relationship of the trigger signal and the measuring signal(s). By depressing the TRIG VIEW push-button, the external trigger signal (fed to input socket X7) is displayed as a third channel with the threshold near the horizontal central graticule line. By adjusting the LEVEL/SLOPE (R7, S7) control, it is easy to determine which part of the trigger signal is initiating the sweep. This is also possible for signals internally derived from the A or B channel when push-button A or B of switch S22 is depressed.

The sensitivity control of the external trigger view mode has two steps, 50 mV/div and 0,5 V/div.
With the push-button switch EXT (S22) depressed the deflection factor is 100 mV/div which is compatible with ECL levels.
In the mode EXT ÷ 10 (S22) the deflection factor is 1 V/div which is compatible with TTL levels.

2.2.8.2. Single shot

With control LEVEL/SLOPE (R7, S7) the trigger level can be set at a predetermined value without the need of an input signal. This is of importance when the signal to be measured is not available in advance as when single events are under test. When input signals, which surpass a known threshold, have to be displayed, the trigger level (R7, S7) can be set in advance and an input signal of sufficient amplitude will initiate the time-base sweep.

The procedure to set the trigger level is as follows: Depress push-button TRIG VIEW.
Position the trace by means of the LEVEL (R7) control so many divisions in opposite direction (in relation to the horizontal central graticule line) as the trigger threshold is required.

Note: The trigger threshold is defined as the distance between the triggerpoint and the zero line of the amplifier (i.e. without input signals and deflection by means of POSITION controls).

2.2.9. Operation of the storage functions

MEMORY OFF mode

If the STORE and WRITE buttons are depressed the storage function is switched off and the instrument functions as a normal oscilloscope. In this mode, the INTENS knob controls the brightness of the displayed waveform. The FOCUS knob is used to obtain maximum sharpness of the display.
Blocking the memory system. If the instrument is waiting in the FAST mode (after the ERASE cycle has ended) for the time-base sweep, the instrument can only be put in the MEMORY OFF mode and not in the WRITE or STORE mode. The instrument can be put in the WRITE or STORE mode if the complete erase/write cycle of the FAST mode has been completed: in other words, only after the time-base has run and the image transfer has occurred.

WARNING: In the MEMORY OFF position, especially in the EXT X DEFL mode, excessive intensity for a prolonged period may damage the c.r.t.

WRITE mode

The waveform is recorded with normal writing speed. The position of the INTENS control determines the intensity of the waveform that is written on the storage layer of the c.r.t. Depending on the position of the PERSISTENCE control, a rapidly vanishing picture will be written on a green background (control entirely counter-clockwise) or a slowly vanishing trace on a black background (control adjacent to its first clockwise stop). The PERSISTENCE can be set to suppress any flickering when displaying a low frequency signal.
For a signal with a low repetition rate and a short rise-time the PERSISTENCE can be set so up to fill up the trace in order to obtain a clear and steady display.
The writing speed can be increased by a factor of approximately 10 by putting the PERSISTENCE control in the MAX position.

FAST mode

The waveform is recorded with high writing speed. The position of the INTENS control determines the intensity of the waveform that is written on the storage layer of the c.r.t. This mode is a single shot mode. If the VIEW TIME control is out of the MAX position the following cycle is repetitively performed. The stored picture is ereased and after that another picture is written when the time-base is triggered. After an adjustable viewing time the following cycle starts with the erasure of the c.r.t. screen. The viewing time is adjustable with the VIEW TIME control between 3 seconds (control entirely counter-clockwise) and 8 seconds (control adjacent to its first clockwise stop).
If the VIEW TIME knob is switched to the MAX position, recording of a new picture only occurs after the ERASE button has been depressed. In this mode it is also possible to transfer the instrument to the STORE mode after the time-base has run and a new picture is written.

For this function proceed as follows: put the instrument in the FAST mode and ERASE the picture. After this, the instrument will wait for a trigger signal. Now depress the STORE pushbutton and the instrument will transfer to the STORE mode after the new picture is written. To obtain a good quality picture, the waiting period for the trigger signal must not exceed one minute.

STORE mode

This mode enables storage of a recorded waveform for a longer time than is available on the PERSISTENCE control. The INTENS control is operative: with the control adjacent to its first counter-clockwise stop, a long storage time of approximately one hour is available.
The waveform is not visible in this position.
With the INTENS control turned entirely clockwise the storage time is short: for figures see the section 'Characteristics'. Here, the waveform is clearly visible. The ERASE pushbutton is not operative in the STORE mode.

ERASE FACILITY

When the trace is no longer required it can be erased by pushing the ERASE button (not operative in the STORE mode). Occasionally, the trace may not entirely disappear, especially those parts which were written with substantial brightness.
The remaining trace can be removed by prolonged actuation of the ERASE button.

Bedienungsanleitung

1. ALLGEMEINES

1.1. EINLEITUNG

PM 3266 ist ein tragbares Speicher-Oszilloskop mit sehr hoher Schreibgeschwindigkeit (1000 Teil/μs). Das Gerät ermöglicht die Messung von Signalen bei sehr hoher Empfindlichkeit (2 mV/Teil) über eine grosse Bandbreite (100 MHz). Das Oszilloskop ist mit vielen integrierten Schaltungen bestückt wodurch sehr stabiler Betrieb gewährleistet ist und die Zahl der Einstellorgane verringert wird. Zur Erleichterung von Prüfung und Einstellung sind an geeigneten Stellen rund um die Schaltung Messpunkte vorgesehen. Das Gerät besitzt verschiedene Speicherfunktionen wie Normal- und Eilschreibgeschwindigkeit und automatische Löschung.
Die grosse Auswahl von Darstellungsmöglichkeiten umfasst: Darstellung eines Kanals, zwei Kanäle alternierend oder gechopped; zwei Kanäle addiert mit normaler und invertierter Lage für beide Eingangssignale sowie eine Hauptzeitbasis und eine verzögerte Zeitbasis.
Zusätzliche Besonderheiten des PM 3266 sind der dritte Kanal TRIG VIEW und die ALTernate TB (alternierende Zeitbasis) Möglichkeit.
TRIG VIEW gestattet Darstellung des Triggersignals (intern oder extern angelegt) über einen dritten Kanal durch Drucktastenwahl).
ALT.TB bietet dem Gebraucher eine gleichzeitige Darstellung des Signals auf den beiden von Hauptzeitbais und verzögerter Zeitbasis gelieferten Zeitmassstäben.
Das Oszilloskop PM 3266 hat eine Speisung mit niedriger Verlustleistung und lässt sich mittels eines Umschalters auf zwei Spannungsbereiche, nämlich 90 V bis 140 V und 200 V bis 264 V einstellen. Dadurch erübrigt sich innerhalb dieser beiden Bereiche die dauernde Einstellung auf die örtliche Netzspannung.
Durch alle diese Eigenschaften eignet sich das Oszilloskop für einen ausgebreiteten Einsatzbereich.

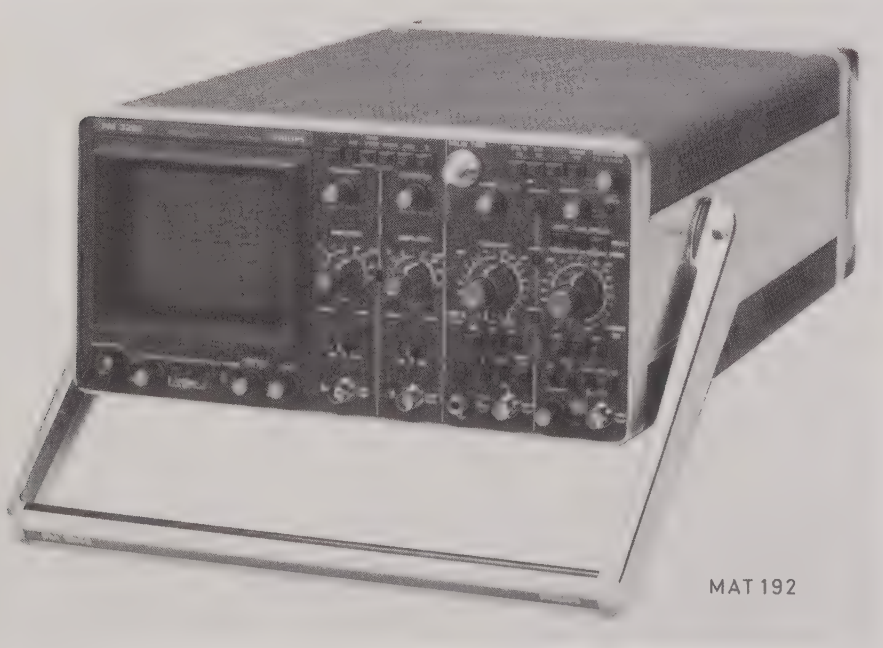


Abb. 1.1. Tragbares Zweistrahl-Speicher oszilloskop PM 3266

1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreien Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender der Hinweise und Warnvermerke beachten, die in dem vorliegenden Gerätehandbuch enthalten sind.

Nur Angaben mit Toleranzen oder Grenzwerten können als garantierte Daten angesehen werden. Daten ohne Toleranzen, d.h. ohne Fehlergrenzen, sind informative Daten und werden nicht garantiert.
Die Daten gelten nach einer Anwärmzeit von 30 Minuten nach dem Einschalten.
Prozentuale und absolute Fehler sind auf den jeweils angegebenen Referenzwert bezogen.

1.2.1. Bildteil

Benennung	Beschreibung	Näher Angaben
Elektronenstrahlröhre	Philips L14-140GH/95	Speicherröhre mit hoher Schreibgeschwindigkeit, Bildübertragung und Vergrösserung der vertikalen Ablenkempfindlichkeit, mittels eines elektronischen Linsensystem (scan magnification) Rechteckiger Schirm, Nachbeschleuniger und metallhinterlegter Leuchtschirm.
Ausnutzbare Schirmfläche	8 x 10 Teile	1 Teil = 0.9 cm. Vertikale und horizontale Linien müssen gerade sein im Zentralen 7 x 9 DIV Schirmgebiet.
Schirmtyp	P31 (GH) Phosphor	
Gesamte Beschleunigungsspannung	10 kV	
Raster	Intern	Nicht beleuchtet
Einteilung	Gestrichelte Linien bei 1,5 und 6,5 Teil vom oberen Bildschirm dienen als Messraste zur Prüfung der Anstiegszeit	
Schreibgeschwindigkeit	1000/Teil/µs	Bei Betriebsart FAST. Nicht garantiert für das Quadrat 2 x 2 Teil in jeder Schirmecke.
	2,5 Teil/µs	Bei Betriebsart Write und Stellung MAX
	0.25 Teil/µs	Bei Betriebsart WRITE
Speicherzeit	1 Stunde max.	Betriebsart STORE: Abhängig von der Stellung von Knopf INTENS (Helligkeit)
	60 Sek.	Bei Betriebsart WRITE (maximale Helligkeit)
	15 Sek.	Bei Betriebsarten MAX WRITE und FAST (maximale Helligkeit)
Nachleuchtdauer	0,3 S. . . 1 min.	Wirksam bei Betriebsart WRITE Stufenlos einstellbar

Automatische Löschung	Wirksam bei Betriebsart FAST mit VIEW TIME aus Stellung Max. Betrachtungszeit zwischen 3 s und 8 s stufenlos einstellbar.	Beim automatischen Löschberieb wird folgender Zyklus ansgeführt: Das Bild wird gelöscht. Wenn die Zeitbasis getriggert ist, wird ein neues Bild geschrieben. Nach der eingestellten Signal darstellungszeit beginnt der neue Zyklus und das Bild wird gelöscht u.s.w. Bei Betriebsart FAST sind die Drucktasten AUTO, TRIG und SINGLE nicht wirksam. Ihre Funktion wird von der Speichereinheit übernommen.
Löschzeit	1,3 s bei Betriebsart WRITE, 1,6 s bei Betriebsart FAST	Die angegeben Werte stellen die Zeit dar, die zwischen Auslösung der Taste ERASE und dem Ende des Löschzyklus verstreicht. Mit Taste ERASE erfolgt die Rückstellung der Hauptzeitbasis.
Ausrichtung der Leuchtspur (TRACE ROTATION)	Schraubenziehereinstellung	Ist über eines der Belüftungslöcher an der Linken Seite das Geräts zugänglich

1.2.2. Vertikale oder Y-Achse

1.2.2.1. Kennlinie (2 mV Bereich ausgenommen)

Frequenzbereich	DC ... 100 MHz AC 7 Hz ... 100 MHz	–3 dB, Gleichspannungskopplung –3 dB, Wechselspannungskopplung Der Frequenzbereich beinhaltet einen 10:1 Messkopf über 20-30 °C.
Anstiegzeit	3.5 ns	
Überschwingen	± 4 % Spitze-Spitze	Über 6 Teile, +5-+40 °C

1.2.2.2. Ablenkkoeffizient

	(für Kenndaten des 2 mV Bereichs siehe 1.2.2.13.).
2 mV/Teil ... 5 V/Teil	Elf kalibrierte Stellungen, Folge 1-2-5. Nicht kalibriert stufenlos einstellbar 1:2,5 Nichtkalibriert Lampenanzeige.

	Benennung	*Beschreibung*	*Nähere Angaben*
	Fehlergrenze	± 3 %	Ausgenommen Linearität der Elektronenstrahlröhre
	Hochstzulässige Eingangsspannung	± 400 V 800 V_{ss}, Wechselspannung	Gleichspannung + Spitzenwert einer Wechselspannung. Minderung bei Frequenzen über 500 kHz.
	Maximale unverzerrte Ablenkung	24 Teile	Bis 35 MHz
	Verschiebungsbereich	16 Teile	Je 8 Teile über und unter der mittleren Rasterlinie.
1.2.2.3.	*Eingangsimpedanz*	1MΩ (± 2%) //≈ 15pF	
	Zeitkonstante der Eingangsschaltung	22 ms	Kopplungsschalter auf AC
1.2.2.4.	*Instabilität*		(2 mV/Teil Einstellung siehe 1.2.2.13.).
	Instabilität des Leuchtflecks	0.1 Teil/Stunde	Temperaturbereich 20 - 40 °C.
	Bildsprung	0,2 Teil	Beim Schalten zwischen einer der Stellungen des Abschwächers
	Bildsprung	0,5 Teil	Beim Schalten des NORM/INVERT Schalters
	Bildverschiebung	0.2 Teil	Beim Drehen des kontinuierlichen Abschwächers. 0.4 Teil in 5 mV Stellung
	Bildverschiebung	1 Teil	Beim Eindrücken der Taste ADDED 0.4 Teil in 5 mV Stellung Ansteigend beim Drehen des stufenlosen Abschwächers.
1.2.2.5.	*Kurzzeit-Temperaturdrift*	Wie 1.2.2.6.	
1.2.2.6.	*Langzeit-Temperaturdrift*	20 µV/°C	Typischer Wert
1.2.2.7.	*Sichtbare Signalverzögerung*	Ca. 15 ns	
1.2.2.8.	*Darstellungsarten*	Kanal + oder –A allein Kanal + oder –B allein Darstellung des Triggersignals allein Kanäle ± A und ± B gechoppt Kanäle ± A und ± B alternierend Kanäle ± A und ± B addiert Triggersignalbild ± A und ± B gechoppt oder alternierend (3-Kanal Anzeige)	Wenn 3-Kanal Anzeige zusammen mit alternierender Zeitablenkdarstellung gewählt ist, erfolgt dies automatisch in aufgehellter Zeitablenkungsart. Siehe 1.2.2.12 für alle Kenndaten der Triggersignal-Darstellung.
1.2.2.9.	*Chopperfrequenz*	≈ 1 MHz	Anzeigedauer pro Kanal ca. 350 ns
1.2.2.10.	*Übersprechen zwischen Kanälen*	1:500	Bis 50 MHz. Mit acht Teilen der Signalamplitude auf einem Kanal. Übersprechen auf dem anderen Kanal innerhalb Zeitbasislinienbreite bis auf 35 Mc. Beide Abschwächer in gleicher Einstellung.
1.2.2.11.	*Gleichtaktunterdrückung*	Besser als 100 bis 2 MHz 20 bei 50 MHz	Gemessen bei +A und –B addiert. Max. Gleichtaktsignal 8 Teile

Benennung	*Beschreibung*	*Nähere Angaben*
1.2.2.12. Triggersignal Darstellung		
Anzeige	Externes oder internes Triggersignal	
Ablenkkoeffizient	Gleich an vertikal	
Extern	100 mV/Teil ± 3 %	
Extern ÷ 10	1 V/Teil ± 5 %	
Intern	Vertikal ± 10 %	
Triggerpunkt	Schirmmitte ± 0,3 Teil	Gleichspannungskopplung
Überschwingen	± 10 % Spitze-Spitze	
Verzögerungszeit zwischen Vertikaleingang und externem Eingang	3 ns ± 1 ns	
Bandbreite	80 MHz	Typischer Wert
1.2.2.13. Kenndaten für die 2 mV/Teil Einstellung		
a. Ablenkkoeffizient	2 mV/Teil	
Fehlergrenze	± 5 %	
b. Kennlinie		
Frequenzbereich	d.c. 0 ... 35 MHz	–3 dB
	a.c. 7 Hz ... 35 MHz	–3 dB
Anstiegzeit	10 ns	
Überschwingen	± 5 % Spitze-Spitze	
Gleichtaktunterdrückung	Besser als 100 bis 2 MHz	
c. Instabilität		
Instabilität der Leuchtspur	0,25 Teil/Stunde	20-40 °C Temperaturbereich
Bildsprung	1 Teil	Beim Umschalten vom 5 mV auf 2 mV Abschwächerstellung
Bildsprung	2 Teile	Bei Betätigung des Schalters NORM/INVERT
Bildverschiebung	1 Teil	Beim Drehen des kontinuierlichen Abschwächers.
Bildverschiebung	1 Teil	Beim Schalten auf Stellung ADDED

1.2.3. Horizontale oder X-Achse

1.2.3.1. Darstellungsmöglichkeiten	– Hauptzeitablenkung	
	– Hauptzeitablenkung aufgehellt durch verzögerte Zeitablenkung	
	– Verzögerte Zeitablenkung	
	– Hauptzeitablenkung aufgehellt und verzögerte Zeitablenkung alternierend dargestellt	Leuchtspurentrennung von 4 Teilen möglich
	– X-Y und X-Y/Y Betrieb	X-Ablenkung durch: – Kanal A Signal – Kanal B Signal – Signal über EXT Anschluss der Hauptzeitablenkung – Netzspannung

	Benennung	*Beschreibung*	*Nähere Angaben*
1.2.3.2.	*Horizontaldrift in X1 Stellung*	0,2 Teil/Stunde	Die Horizontaldrift bei X1 Dehnung darf 0,1 Teil/Stunde über 20-40 °C Temperaturbereich nicht überschreiten. Die gleichen Stabilitätsbedingungen gelten für den Start der Ablenkung bei Änderungen der Ablenkgeschwindigkeitseinstellung, ausgenommen sind die höchsten Ablenkbereiche (50-100 ns/Teil)
1.2.3.3.	*Horizontalverschiebung*	± 5,2 Teile von Schirmmitte	Der Steller für die Horizontalverschiebung umfasst Grob- und Feineinstellung.
1.2.4.	**Hauptzeitablenkung**		
1.2.4.1.	*Betriebsart*	Getriggert Automatisch Einmalig	Automatischer Freilauf bei Abwesenheit von Triggersignalen nach weniger als 0,1 s.
1.2.4.2.	*Zeitmassstäbe*	1 s/Teil ... 50 ns/Teil	In 23 Kalibrierten Stufen, Folge 1-2-5 Dazwischen stufenlos einstellbar 1:2,5 nicht kalibriert. Eine Lampe UNCAL (nichtkaliebriert) für sowohl Hauptzeitablenkung wie verzögerte Zeitablenkung (MTB und DTB).
1.2.4.3.	*Fehlergrenze des Zeitmassstabes*	±2 % ±3 %	+20 °C ... +30 °C + 5 °C ... +40 °C
	Die Differenz in Ablenkgenauigkeit über beliebige 2 Teile		Die Differenz in Zeitablenkungs-Genauigkeit für 2 beliebige Teile von 10-Teil-Zeitablenkung ist ± 5%. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
1.2.4.4.	*Anzeigendehnung*		
	Dehnung	10x	Geschaltet, kalibiriert. Wenn das Bild mit der mittleren horizontalen Rasterlinie zusammenfällt darf es beim Ändern der horizontalen Dehnung von X1 auf X10 um nicht mehr als 1 Teil verschieben.
	Koeffizientfehler	± 1 % zusätzlich	± 5 % bei den ersten und letzten 50 ns von 5 ns/Teil, 10 ns/Teil und 20 ns/Teil der gedehnten Zeitablenkung.
	Kürzester Zeitmassstab	5 ns/Teil	
1.2.4.5.	*Regelbare Sperrzeit ("hold-off")*	Die Sperrzeit der Zeitablenkung kann bis zum Faktor 10 vergrössert werden.	
1.2.5.	**Verzögerte Zeitablenkung**		
1.2.5.1.	*Betriebsart*	Verzögerte Zeitablenkung startet nach Wahl, entweder sofort nach Ablauf der Verzögerungszeit oder nach Empfang des ersten Triggerimpulses nach Verstreichen der Verzögerungszeit.	

	Benennung	*Beschreibung*	*Nähere Angaben*
1.2.5.2.	*Langzeitstabilität des Komparators*	< 2 Teil bei 1000 mal Dehnung	Mit Hauptzeitablenkung bei 1 ms/Teil und verzögerte Zeitablenkung bei 1 µs darf eine gewählte Signaleinzelheit in verzögerter Zeitablenkungsart nach Anwärmzeit nicht mehr als zwei Teile bewegen.
1.2.5.3.	*Zeitmassstäbe*	0,5 s/Teil ... 50 ns/Teil	In 22 kalibrierten Stufen (Folge 1-2-5). Dazwischen stufenlos einstellbar 1:2,5 nicht kalibriert. Eine Lampe UNCAL (nichtkalibriert) für sowohl Hauptzeitablenkung wie verzögerte Zeitablenkung (MTB und DTB).
1.2.5.4.	*Fehlergrenze des Zeitmassstabes*	±2 % ±3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Die Differenz in Zeitablenkungs-Genauigkeit für zwei beliebige Teile von 10-Teil-Zeitablenkung ist ± 5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
1.2.5.5.	*Verzögerungszeit*	Stufenlos zwischen 0x und 10x der Zeitkoeffizient, der Hauptzeitablenkung	Kalibriert. Bereich des Verzögerungszeitvervielfachers 0,00-9.99 Inkrementale Genauigkeit 0,5 %, typisch 0,2 %.
1.2.5.6.	*Verzögerungszeitjitter*	1 : 20.000	
1.2.6.	**X-Ablenkung**		
	X-Ablenkung über Kanal Y_A oder Y_B	2 mV/Teil ... 5 V/Teil	Nichtkalibrierte stufenlose Einstellung 1:2,5 über Potentiometer Y GAIN.
1.2.6.1.	*Koeffizientfehler*	± 5 %	
1.2.6.2.	*Bandbreite*	0 - 2 MHz	–3 dB Bandbreite über 4 Teile
1.2.6.3.	*Maximale unverzerrte Ablenkung*	20 Teile	bis zu 100 kHz
1.2.6.4.	*Phasenverschiebung bezogen auf Y Darstellung*	3° bei 100 kHz	
	Externe X-Ablenkung über Buchse EXT		
1.2.6.5.	*Ablenkkoeffizient*		
	Ext Ext. ÷ 10	50 mV/Teil 500 mV/Teil	Nichtkalibrierte stufenlose Einstellung 1:3
1.2.6.6.	*Genauigkeit Ext.: 1*	± 3 %	Zusätzlich 2 % für Ext.: 10
1.2.6.7.	*Bandbreite*	d.c. ... 2 MHz 7 Hz ... 2 MHz	Über DC Triggerkopplung Über NF oder HF Triggerkopplung
1.2.6.8.	*Eingangscharakteristiken*	Gleiche Werte wie Y-Kanäle	
1.2.6.9.	*Phasenverschiebung bezogen auf Y-Kanäle*	3° bei 100 kHz	

Benennung	*Beschreibung*	*Nähere Angaben*
1.2.6.10. Linearität	1,5 %	
1.2.6.11. Drift	0,2 Teil/Stunde	
1.2.7. Triggerung der Hauptzeitablenkung		
1.2.7.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Zusammengesetzt A und B Intern von Netz Extern Extern: 10	Nur Betriebsart vertikal alternierend
1.2.7.2. Betriebsart	Automatische Triggerung	Automatischer Freilauf des Zeitablenkgenerators etwa 100 ms nach Verschwinden des Triggersignals.
	Normale Triggerung Einmaliger Ablauf der Zeitablenkung	Lampe NOT TRIG'D leuchtet nach Rückstellung und erlischt am Ende der Ablenkung.
1.2.7.3. Flanke	+ oder –	
1.2.7.4. Empfindlichkeit	Internal: 0,5 div bis 1,5 div bei 100 MHz.	Typischer Wert, frequenzabhängig
	External: 50 mV bis 150 mV bei 100 MHz.	Typischer Wert, frequenzabhängig
	External ÷ : 500 mV	
1.2.7.5. Filterbandbreite	DC – ganze Bandbreite NF int.: 0 - 30 kHz NF ext.: 7 Hz - 30 kHz HF : 30 kHz - 100 MHz	Intern und extern –3 dB –3 dB –3 dB, intern und extern
1.2.7.6. Pegelbereich		
Interne Triggerung Externe Triggerung Extern: 10	24 Teile +1,2 V bis –1,2 V +12 V bis –12 V	
1.2.7.7. Eingangsimpedanz	$1M\Omega (\pm 2\%) // \approx 15pF$	
1.2.7.8. Triggerjitter	Besser als 0,5 ns	
1.2.8. Triggerung der verzögerten Zeitablenkung		
1.2.8.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Extern	Übrige Eigenschaften sind die gleichen wie bei TRIGGERUNG DER HAUPTZEITABLENKUNG, ausgenommen Ext÷10 und Netztriggerung
1.2.9. Kalibrierungseinheit		
1.2.9.1. Ausgangsspannung	$3 V_{ss}$	
1.2.9.2. Ausgangsstrom	6 mA	
1.2.9.3. Fehlergrenze	± 1 %	Spannung und Strom

Benennung	*Beschreibung*	*Nähere Anlage*
1.2.9.4. Frequenz	2 kHz ± 2 %	
1.2.9.5. Sicherung	Der Ausgang ist gegen Dauerkurzschlüsse gesichert	

1.2.10. Eingänge/Ausgänge an Rückseite

1.2.10.1. Z-Achsensteuerung	Gleichspannungsgekoppelt TTL-Kompatibel Positive Polarität verstärkt das Bild. Ansprechzeit 35 ns. Eingangsimpedanz 10 kΩ Max. Eingangsspannung 50 V	
1.2.10.2. Torausgang der Hauptzeit ablenkung	0 ... +5 V geliefert während der Hauptzeitablenkung	Wahlweise erhältlich, Ausgangsimpedanz 1 KOhm.
1.2.10.3. Torausgang der verzögerten Zeitablenkung	0 ... +5 V geliefert während der verzögerten Ablenkung	Wahlweise erhältlich, Ausgangsimpedanz 1 KOhm

1.2.11. Speisung

1.2.11.1. Netzspannungen	AC 90 – 140 V AC 200 – 264 V DC 250 – 350 V	Automatisch gegen falsche Einstellung des Netzwahlschalters geschützt.
1.2.11.2. Netzfrequenz	46 bis 440 Hz	
1.2.11.3 Leistungsaufnahme	50 W	
1.2.11.4. Sprunghafte Netzänderungen		Bei Auftreten von sprunghaften Spannungsänderungen kann der Oszillograf nicht beschädigt werden, entsprechend den MIL-T-28800 Bedingungen.

1.2.12. Einflussgrössen

Die angegeben Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden.

1.2.12.1. Temperaturprüfungen

Nach Vorschriften IEC 68 Ab und Bb.
Arbeitsbereich: –15 °C ... +55 °C.
Betrieb innerhalb Spezifikation: +5 °C ... +40 °C. Ausgenommen die pro Spezifikation angegebenen Toleranzen.
Lagerung: –55 °C ... +75 °C.

1.2.12.2. Höhe

Nach Vorschriften IEC 68-2-13, Test M
Arbeitshöhe: bis 5000 m
Minderung: 1 °C/300 m für die max. Arbeitstemp.
Lagerung: bis 17.000 m.

1.2.12.3. Stossfestigkeit

In Betrieb: 30 g, ½ Sinus, Dauer 11 ms, 2 Stösse pro Achse pro Richtung bei insgesamt 12 Stössen.

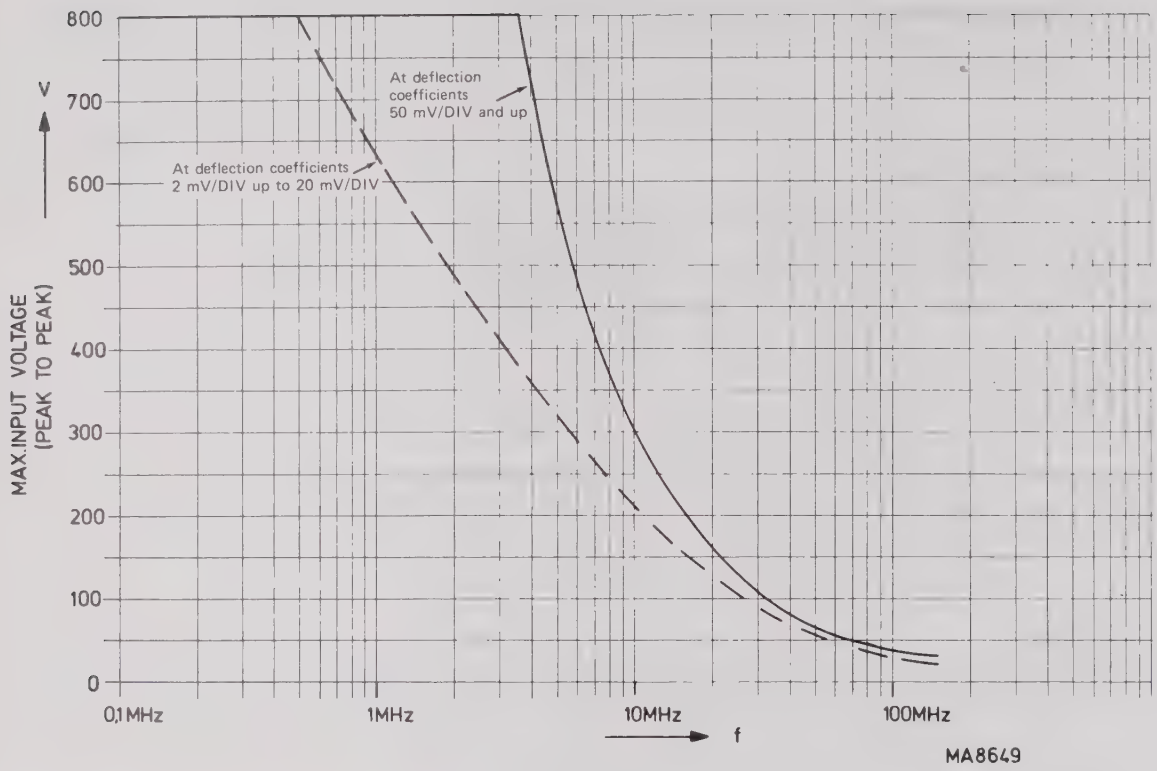


Abb. 1.2. Minderung der höchstzulässigen Eingangsspannung

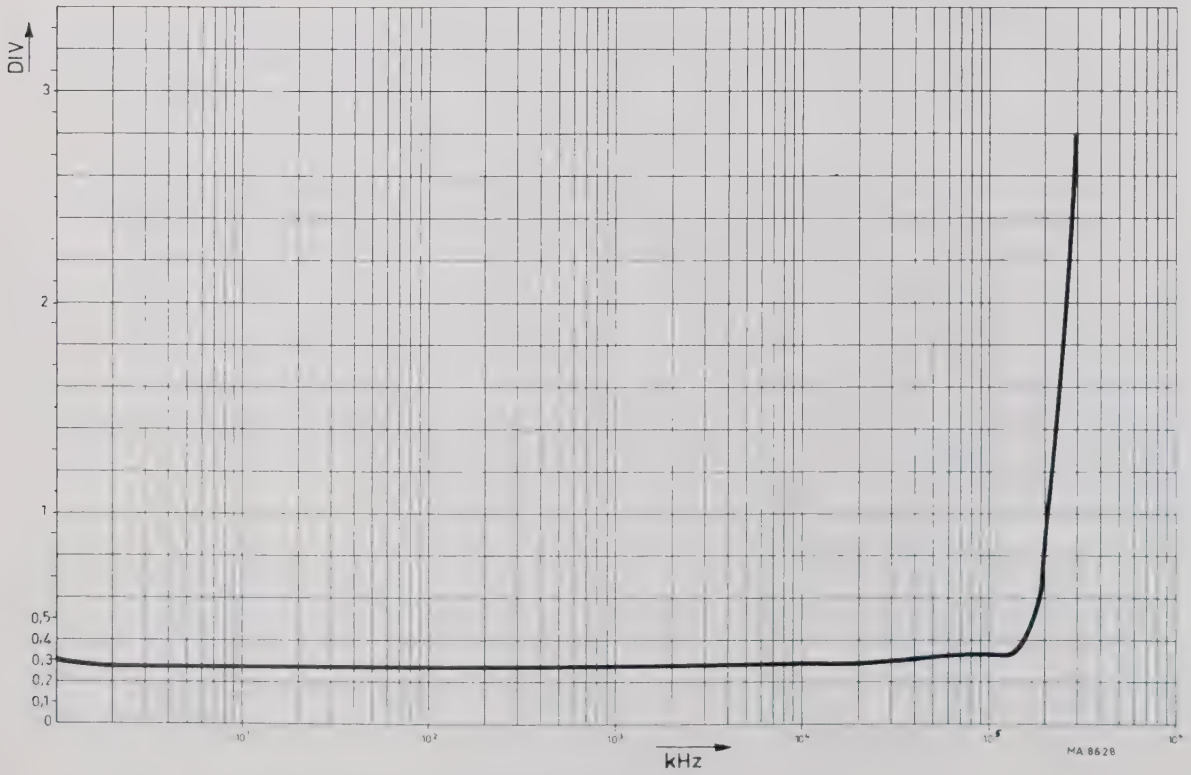


Abb. 1.3. Typische Ablenkempfindlichkeit für interne Triggerung über Kanal A.

1.2.12.4. Vibration

In Betrieb: 15 Minuten entlang jeder der 3 Achsen
0,025" Spitze-Spitze Verlagerung (4 g bei 55 Hz) bei einer Frequenz variierend von 10 Hz nach 55 Hz nach 10 Hz. in Zyklen von einer Minute.

1.2.12.5. Akklimationszeit

Arbeitet innerhalb 30 Minuten, kommend von −10 °C nach Raumbedingungen von +20 °C bei 60 % relativer Luftfeuchte.

1.2.12.6. Magnetische Abschirmung

Nach IEC 351 - 22.3.1.
Maximale Abweichung 1 Teil.

1.2.12.7. Störgrad

Den Vorschriften VDE 0871 und 0875, Störgrad K entsprechend.

1.2.13. Mechanische Daten

1.2.13.1. Abmessungen	Länge	460 mm	Ohne Bedienungsorgane, Deckel und Füsse
	Breite	316 mm	
	Höhe	154 mm	
1.2.13.2. Gewicht	10,9 kg		

1.3. ZUBEHÖR

1.3.1. Mit dem Gerät geliefertes Zubehör

- 2 passive 10:1 Messköpfe
- Kontrastfilterscheibe
- Abdeckhaube mit Aufbewahrungsraum
- Faltbarer Lichtschutztubus PM 9366
- BNC Übergangsstecker PM 9051
- CAL Anschlussklemme - BNC Adapter
- Anleitung.

1.3.2. Wahlzubehör

PM 8921	Passiver Messkopfsatz 1:1 (1,5 m)
PM 8921L	Passiver Messkopfsatz 1:1 (2,5 m)
PM 8935	HF passiver Messkopfsatz 10:1 (1,5 m)
PM 8935L	HF passiver Messkopfsatz 10:1 (2,5 m)
PM 8932	Passiver Messkopfsatz 100:1
PM 8994	Satz Messkopfzubehören
PM 9353	Aktiver FET-Messkopf 1:1, 10:1. 100:1; 3,5 pF (1,5 m)
PM 9355	Strommesskopf: 1 mA/Teil ... 1 A/Teil 12 Hz ... 70 MHz
PM 9346	Stromversorgung für aktive Messköpfe
PM 8960	19"-Gestelleinbausatz
PM 8992	Zubehörtasche
PM 9380	Oszillografenkamera
PM 8971	Adapter für Oszillografenkamera
PM 8910	Polaroid Anti-Reflex Filter
PM 8980	Langer Einblicktubus
PM 8901	Batteriespeisung 24 und 280 V Gleichspannung
PM 8991	Rollwagen
800/NTX	Abgleichstifte

Steinheil Oszillophot System: Mit Hilfe des Steinheil Adapters 1820/50 lassen sich die Kameras M3, M4 und M5 am Oszillograf befestigen.

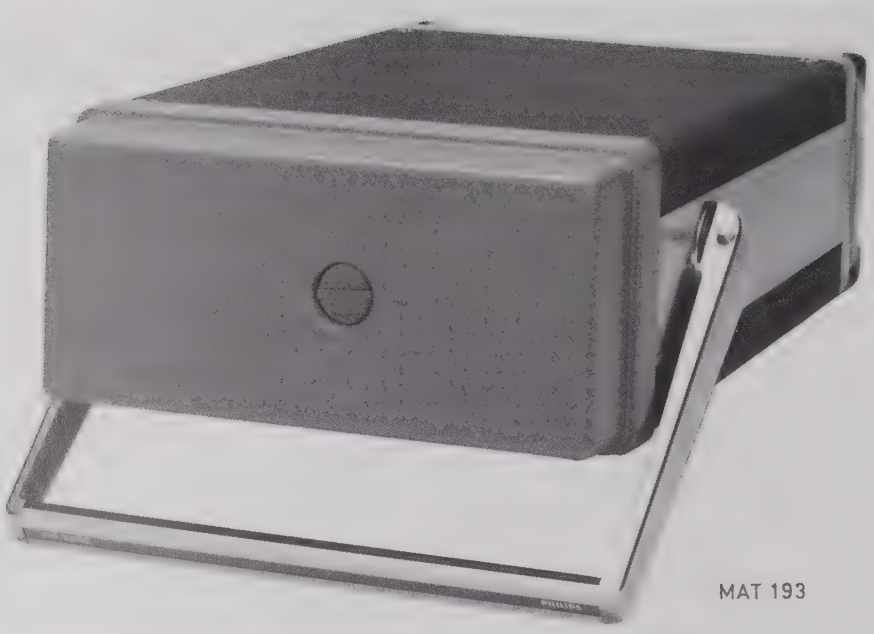


Abb. 2.1. Abnehmen der Abdeckhaube

Abb. 2.2. Rückansicht des Geräts

2. Bedienungsanleitung

2.1. ALLGEMEINES

Dieser Abschnitt gibt einen Überblick der für die Inbetriebnahme des PM 3266 erforderlichen Handlungen und Vorsichtsmassregeln. Er beschreibt und erläutert in Kürze die Funktion der Bedienungsorgane auf Frontplatte und Rückwand sowie der Anzeigen. Ausserdem sind hier die praktischen Gesichtspunkte der Bedienung erklärt, dies ermöglicht dem Bedienungsmann eine rasche Bewertung der Hauptfunktionen des Geräts.

2.1.1. Inbetriebnahme

Bevor irgendeine Verbindung ausgeführt wird muss die Erdanschlussklemme an einen Schutzleiter angeschlossen werden (siehe Abschnitt Erdung).

WARNUNG: Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend und somit lebensgefährlich sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein. Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundenen Gefahren kennt.
Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde.

2.1.2. Abnehmen und Aufsetzen der Abdeckhaube

Abnehmen :
- Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen (Stellung UNLOCKED).
- Deckel abnehmen.

Aufsetzen :
- Den Verriegelungsknopf in Stellung UNLOCKED drehen.
- Deckel an der Vorderseite des Oszillografen befestigen.
- Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED)

Bemerkung: Der Handgriff lässt sich drehen wenn die Druckknöpfe auf ihren Lagern eingedrückt werden.

2.1.3. Netzspannungseinstellung und Sicherung

Da das Gerät bei jeder Netzspannung zwischen 90 und 140 V (mit der erwähnten Spannungsgrösse am CIRCUIT BREAKER sichtbar) und zwischen 200 V und 264 V (auch sichtbar durch das Fenster an der Rückwand) Betriebsfähig ist, erübrigt sich Anpassung an die örtliche Netzspannung, sobald der entsprechende Spannungsbereich eingestellt ist.

Der an der Rückwand angebrachte Sicherungshalter enthält eine Sicherung, 2 A, träge.
Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalter sind nicht zulässig. Das Gerät muss von allen Spannungsquellen getrennt sein wenn eine Sicherung ersetzt wird.

Bemerkung: Sowohl für die 90 V ... 140 V einstellung, wie auch für die 200 V ... 264 V Einstellung, wird die gleiche Sicherung, 2 A träge, benutzt.

2.1.4. Erdung

Vor dem Einschalten muss dass Gerät auf eine der folgenden Weisen mit einem Erdschutzleiter verbunden werden:

- über den Erdanschluss (gekennzeichnet ⏚).
- über das dreiadrige Netzkabel. Der Netzstecker darf nur in eine Schutzkontaktdose eingeführt werden. Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch Verwendung einer Verlängerungsleitung ohne Schutzleiter.

Ersetzen des Netzsteckers geschieht auf eigene Gefahr.

WARNUNG: Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Geräts ist unzulässig. Wenn ein Gerät von kalter in warme Umgebung gebracht wird, kann dies zu einem sicherheitstechnisch gefährlichen Zustand führen. Deshalb sind alle Erdungsvorschriften sorgfältig zu beachten.

2.1.5. Einschalten

Der Netzschalter POWER ist gekoppelt mit der Einsteller INTENS und befindet sich an der Vorderseite des Gerätes unter dem Bildröhrenrahmen. Die Anzeiglampe POWER ON/OFF befindet sich neben Einsteller INTENS. Der Oszillograf darf niemals eingeschaltet werden, wenn eine Leiterplatte entfernt wurde. Einer Leiterplatte darf nicht früher als eine Minute nach Ausschaltung des Gerätes entfernt werden.

2.2. BEDIENUNGSANWEISUNGEN

Vor dem Einschalten ist zu kontrollieren, ob der Oszillograf gemäss Abschnitt 2.1. "INBETRIEBNAHME" angeschlossen ist, und ob die dort erwähnten Vorsorgemassnahmen beachten wurden.

2.2.1. **Bedienungsorgane und Buchsen** (Abb. 2.3.)

2.2.1.1. Vertikalkanäle

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Einstellung der vertikalen Darstellungsarten, Drucktastenschalter mit 6 Stellungen.
A eingedrückt	Vertikalablenkung durch an Kanal A gelegtes Signal.
ALT eingedrückt	Das Bild wird am Ende (jeder Periode) des Zeitablenksignales von einem Vertikalkanal auf den anderen umgeschaltet, das heisst Kanäle A und B werden auf ALTernierender Ablenkung dargestellt.
TRIG VIEW eingedrückt	Die Anzeige wird für Sichtbarmachung des gewählten Triggersignal geschaltet. Darstellung des Triggersignals ist inter über A oder B kanal möglich (A oder B von S22 eingedrückt) oder extern über die externe Eingangsbuchse X7, wenn EXT oder EXT ÷ 10 von S22 eingedrückt ist.
CHOP eingedrückt	Das Bild wird mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet, die beiden Kanäle A und B während der gleichen Ablenkung sichtbar.
ADD eingedrückt	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
B eingedrückt	Vertikalablenkung durch Signal von Kanal B
Keine der Tasten betätigt	Wird keine Taste eingedrückt ist die Betriebsweise des Gerätes wie bei Einstellung ALT.
ALT und TRIG VIEW gleichzeitig eingedrückt	Die Signale auf den Kanälen A, B und TRIG VIEW werden bei alternierenden Ablenkung dargestellt, normalerweise für Hochfrequenzsignale geeignet (siehe auch die Erklärung der Drucktaste TRIG VIEW).
CHOP und TRIG VIEW gleichzeitig eingedrückt	Die Triggersignale auf den Kanälen A und B sind eines nach dem anderen bei CHOP Frequenz während der gleichen Ablenkung sichtbar, normalerweise für Niederfrequenzsignale geeignet. (siehe auch die Erklärung der Drucktaste TRIG VIEW)
POSITION (R3, R4)	Stufenlose Einstellung der vertikalen Lage des Bildes
PULL TO INVERT (S4, S5)	Zweiweg Zug-Druckschalter gekoppelt an Einsteller POSITION zur Umkehrung der Signalpolarität. Eindrücken für NORMAL ziehen für INVERT
AMPL/DIV (S9, S11)	Stufenweise Einstellung der Vertikalablenkkoeffizienten mit 11 Stellungen.
UNCAL (V4, V5)	Lampenanzeige dass sich der Einsteller CAL nicht in Kalibrierstellung befindet.
CAL (AMPL/DIV) (R8/S10,R9/S12)	Stufenlose Einstellung der Vertikalablenkkoeffizienten. In Stellung CAL ist der eingestellte Ablenkkoeffizient kalibriert
GAIN (R12, R13) (Schraubenzieher-einstellung)	Stufenlose Einstellung der Gesamtverstärkung der Vertikalkanäle.

AC, 0, DC (S17, S18)	Signalkopplung, Schalter mit 3 Stellungen.
AC gewählt	Kopplung über einen Sperrkondensator.
0 gewählt	Verbindung zwischen Eingangsschaltung und Eingangsbuchse wird unterbrochen und der Verstärkereingang geerdet.
DC gewählt	Direkte Kopplung Ist keine Taste eingedrückt so gilt Einstellung AC. Für die Beobachtung von langzeitigen Impulsen oder von Gleichspannungspegeln von Signalformen ist es ratsam Stellung DC zu wählen. Stellung AC ist für Wechselspannungssignale mit beträchtlichen Gleichspannungsanteil zu wählen.
A 1 MOhm - 15 pF (X3)	BNC Eingangsbuchse für Kanal A
B 1 MOhm - 15 pF (X4)	BNC Eingangsbuchse für Kanal B

2.2.1.2. Horizontaler Kanal

DEL'D TB, ALT TB, EXT X DEFL, MAIN TB (S2)	Einstellelemente für horizontale Darstellungsart, Drucktastenschalter mit 4 Stellungen.
DEL'D TB eingedrückt	Die Horizontalablenkspannung wird vom verzögerten Zeitablenkgenerator geliefert.
ALT TB eingedrückt	Die horizontale Darstellung wird am Ende jedes Zyklus des Hauptzeitablenkgenerators von der Hauptzeitablenkung auf verzögerte Zeitablenkung umgeschaltet. Nicht wirksam wenn TRIG VIEW eingedrückt oder wenn die verzögerte Zeitbasis auf "OFF" geschaltet ist.
EXT X DEFL eingedrückt	Horizontalablenkung durch ein an die Eingangsbuchse (X7) des Horizontalverstärkers gelegtes Signal, durch ein von Kanal A oder B kommendes Signal, das zusammengesetzte Signal oder Netzfrequenzsignal, je nach Einstellung von TRIG or X DEFL (S22).
MAIN TB eingedrückt	Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert; ein Teil der Darstellung wird aufgehellt (Ausgenommen in Stellung OFF des TIME/DIV Schalters des verzögerten Zeitablenkgenerators). **Ist keine Taste eingedrückt** so gilt Einstellung MAIN TB.
POSITION TB MAGN (R2, S3)	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druck-Schalter der den Horizontalablenkkoeffizienten 10 mal steigert (PULL FOR X10).
MAGN (V3)	Eine Signallampe leuchtet auf wenn die X10 Dehnung wirksam ist.
X AMPL, HOLD OFF (R18)	Stufenlose Einstellung des Horizontalablenkkoeffizienten bei externer X-Ablenkung. Bei X-Ablenkung durch die Hauptzeitablenkung kann diese Einstellung zur Steigerung der Sperrzeit benutzt werden.
TRACE STEP (R6)	Stufenlos regelbare Voreinstellung des vertikalen Abstands zwischen den beiden Zeitablenkungs-Darstellungen in Betriebsart ALT TB.

2.2.1.3. Hauptzeitablenkgenerator

LEVEL-SLOPE (R7, S7)	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales (gedrückt "+", gezogen "–").
NOT TRIG'D (V2)	Signallampe leuchtet auf wenn die Zeitablenkung nicht getriggert ist, z.B. bei Wartestellung.

AUTO, TRIG, SINGLE (S8)	Triggerart-Einstellungen; Drucktastenschalter mit 3 Stellungen.
AUTO eingedrückt	Liegt kein Triggersignal an so läuft der Hauptzeitablenker frei.
TRIG eingedrückt	Der Zeitablenkgenerator wird auf normale Weise getriggert.
SINGLE eingedrückt	Nach Betätigung der Taste SINGLE läuft der Zeitablenkgenerator nach Empfang eines Triggersignals nur einmal ab. Wenn keine Taste gedrückt ist gilt Betriebsart SINGLE.
TIME/DIV or DELAY TIME (S15)	Einstellung des Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 23 Stellungen.
CAL (blau) - TIME/DIV (R11, S16)	Stufenlose Einstellung des Zeitkoeffizienten der Hauptzeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
UNCAL (V6)	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrierstellung befindet.
DC, LF, HF (S20)	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt.
LF eingedrückt	Kopplung über Tiefpass für Frequenzen bis 30 kHz (Für externe Triggerung über einen Bandfilter von 7 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
TRIG or X DEFL (S22)	Wähler für Triggerquelle oder externe X Ablenkung. Drucktastenschalter mit 4 Stellungen.
A eingedrückt	Internes Trigger- oder X-Ablenksignal von Kanal A.
B eingedrückt	Internes Trigger- oder X-Ablenksignal von Kanal B.
COMP (A und B gleichzeitig eingedrückt)	Internes Trigger- oder X-Ablenksignal von Kanälen A und B.
EXT	Triggerung auf externes Signal über angrenzende 1 MOhm - 15 pF Buchse (X7). Durch Eindrücken der Taste EXT X DEFL der Horizontalablenkungs-Einstellung wird diese Buchse mit dem Eingang des Horizontalverstärkers verbunden.
EXT ÷ 10	Triggerung und Horizontalablenkung wie bei EXT, jedoch um den Faktor 10 abgeschwächt.
LINE (EXT und EXT ÷ 10 gleichzeitig gedrückt)	Triggerung- oder X-Ablenkungssignal abgeleitet von einer internen Spannung mit der Netzfrequenz. Ist keine Taste eingedrückt so gilt Einstellung A. Wenn keine Taste gedrückt ist, ist keine Betriebsart gewählt.
1 MOhm - 15 pF (X7)	BNC Buchse für externe Triggerung oder Horizontalablenkung.

2.2.1.4. Verzögerter Zeitablenkgenerator

DELAYED TIME Multiplizierter (R1)	Stufenlose Einstellung der Verzögerungszeit, wirkt zusammen mit der TIME/DIV Einstellung des Hauptzeitablenkgenerators.
LEVEL-SLOPE (R5, S6)	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales (gedrückt "+", gezogen "—").
TIME/DIV (S13)	Einstellung des Zeitkoeffizienten der verzögerte Zeitablenkung Drehschalter mit 23 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.
CAL (blau) - TIME/DIV (R10, S14)	Stufenlose Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.

UNCAL (V6)	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrierstellung befindet.
DC, LF, HF (S19)	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt.
LF eingedrückt	Kopplung über Tiefpass für Frequenzen bis 30 kHz (für externe Triggerung über einen Bandfilter von 7 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
A, B, EXT, MAIN TB (S21)	Triggerquellen Einstellung und Startpunkt der verzögerten Zeitablenkung Drucktastenschalter mit 4 Stellungen.
A eingedrückt	Internes Triggerungssignal von Kanal A nach Verzögerungszeit.
B eingedrückt	Internes Triggerungssignal von Kanal B nach Verzögerungszeit.
EXT eingedrückt	Triggerung auf ein externes Signal über angrenzende 1 MOhm-15 pF Buchse.
MAIN TB eingedrückt	Die verzögerte Zeitablenkung startet sofort nach Verstreichen der Verzögerungszeit. Ist keine Taste gedrückt so gilt Einstellung A.
1 MOhm - 15 pF (X6)	BNC-Eingangsbuchse für externes Triggersignal.

2.2.1.5. Elektronenstrahlröhre Bildteil

INTENS/POWER ON	Netzschalter ON/OFF: Wenn das Gerät eingeschaltet ist leuchtet die LED-Anzeige. Bei Betriebsart (MAX) WRITE, FAST oder MEMORY OFF: die Stellung des Knopfes bestimmt die Leuchtdichte der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Bei Betriebsart STORE: Die Stellung des Knopfes bestimmt die Helligkeit der dargestellten Signalform auf dem Bildschirm. Bei erhöhter Helligkeit vermindert die Speicherzeit.
STORE/WRITE/FAST/ERASE	Drucktastenschalter für die Einstellung des Speichersystems.
STORE	Gestattet Speicherung registrierter Signalformen über längere Zeit. Steller INTENS ist wirksam.
WRITE	Gestattet Registrierung der Signalform bei normaler Schreibgeschwindigkeit. Steller PERSISTENCE und INTENS sind wirksam.
FAST	Gestattet Registrierung der Signalform bei hoher Schreibgeschwindigkeit. Die Steller VIEW TIME und INTENS sind wirksam.
ERASE	Zur Löschung der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Dieses Bedienelement ist nicht wirksam bei Betriebsart STORE.
MEMORY OFF	Wenn die Drucktasten STORE und WRITE gemeinsam gedrückt werden, wird die Speicherfunktion der Elektronenstrahlröhre ausgeschaltet.

Das Gerät arbeitet in STORE wenn eine falsche Tastenkombination gewählt ist.

PERSISTENCE/VIEW TIME

Mit diesem Steller wird ein variables Festhalten der geschriebenen Signalform bewirkt (variable Nachleuchtdauer). In Stellung MAX wird die Schreibgeschwindigkeit etwa um einen Faktor 10 erhöht. Die Elektronenstrahlröhre zeigt einige Hintergrundbeleuchtung.
Bei Betriebsart FAST erfolgt automatische Löschung und Aufzeichnung eines neuen Bildes nach einer gewissen Zeit. Diese Zeit wird von der Stellung des Knopfs VIEW TIME betimmt.
Wenn dieser Knopf auf MAX steht erfolgt die Aufzeichnung eines neuen Bildes nur nachdem Taste ERASE eingedrückt ist. Die Elektronenstrahlröhre zeigt jetzt einige Hintergrundbeleuchtung.

FOCUS

Stufenlose Einstellung der Elektronenstrahl-Fokussierung in horizontaler Richtung. Die vertikale Fokussierung wird vom Steller INTENSity beeinflusst. Deshalb bleibt die vertikale Fokussierung beinahe über den gesamten Leuchtdichtebereich eingestellt. Die äussersten Stellungen des Stellers INTENS sind mit Hilfe eines Potentiometers, welches durch ein Belüftungsloch in der linken Seite des Geräts zugänglich sind, einstellbar.
Die höchste Schreibgeschwindigkeit bei Betriebsart FAST wird nur dann erreicht wenn die Fokussierung des Elektronenstrahls optimal ist.

TRACE ROT (R15)

Voreinstellung zur Ausrichtung der Leuchtspur mit den Rasterlinien.
Schraubenziehereinstellung, zugänglich durch ein Belüftungsloch in der linken Seite des Geräts.

2.2.1.6. Verschiedenes

CAL (X1, X2)

Ausgangsbuchse an der eine Rechteckspannung von 3 V_{ss} und ein Strom von 6 mA mit einer Frequenz von 2 kHz für Kalibrierung zur Verfügung steht.

⏚ (X5)

Messerde

Z-MOD (X8) an Rückseite

Eingangsbuchse für externe Z-Modulation.

2.2.2. Vorbereitende Einstellungen

Da die folgenden Einstellungen für beide vertikale Kanäle gleich sind, ist nur die Vorschrift für Kanal A gegeben. Falls nich anders erwähnt sind die Bedienungsorgane in den gleichen Stellungen wie in vorgehender Einstellvorschrift.

2.2.2.1. Verstärkungseinstellung

- Drucktaste AUTO des Triggerart-Wahlschalters (S8) betätigen.
- Drucktaste A des Darstellungsartenschalters betätigen (S1).
- Drucktaste MAIN TB des Horizontalablenkungsschalters betätigen (S2).
- Bild(er) mit Hilfe der entsprechenden Einsteller POSITION entrieren.
- Mit Einstellern INTENS und FOCUS die Bildschärfe regeln.
  Nicht erwähnte Einstellorgane dürfen in jeder beliebigen Stellung stehen.
- Schalter AC-0-DC in Stellung DC.
- Schalter AMPL im Stellung 0,5 V und stufenlosen Einsteller in Stellung CAL.
- Buchse CAL mit Eingangsbuchse A verbinden.
- Prüfen ob die Bildhöhe genau 6 Teile beträgt.
  Nötigenfalls Steller GAIN auf der Frontplatte direkt unter dem Schalter GAIN neu einstellen.

2.2.3. Eingänge A und B und ihre Möglichkeiten

Der Oszillograf besitzt zwei identische Kanäle, die entweder zusammen mit einem oder beiden Zeitablenkgeneratoren für YT Messungen, oder aber zusammen mit dem externen Horizontalkanal für XY Messungen verwendet werden können.

2.2.3.1. YT-Messungen

Zur Darstellung eines Signals ist einer der beiden Vertikalkanäle mit Taste A oder Taste B der Darstellungsartenschalter zu wählen.
Wird Taste ALT oder CHOP gedrückt, können zwei verschiedene Signale gleichzeitig abgebildet werden. Der Y-Ablenkkoeffizient und die Polarität können für jeden Kanal getrennt gewählt werden. Wird Taste ALT betätigt dann wird die Darstellung beim Rücklauf des Zeitablenksignals von einem Kanal auf den anderen umgeschaltet. Obwohl Stellung ALT für alle Ablenkzeiten verwendet werden kann, ergibt für lange Ablenkzeiten Stellung CHOPPED eine bessere Bildgüte, da das abwechselnde Darstellen der beiden Eingangssignale während dieser langen Ablenkzeiten deutlicher sichtbar ist.

In Stellung CHOPPED wird die Darstellung mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet.
In Stellung ADDED des Darstellungsartenschalters werden die Signalspannungen der beiden vertikalen Kanäle addiert. Abhängig von der Stellung der Polaritätsschalter wird entweder die Summe oder die Differenz der Eingangssignale dargestellt. Die Einstellung ADDED ermöglicht auch Differenzmessungen. Bei diesen Messungen wird die Gleichtaktunterdrückung der Stellung ADDED ausgenützt. Wenn die Polaritätsschalter beider Kanäle in entgegengesetzten Stellungen stehen, werden die Gleichtaktteile der Signale von Kanal A und B im Verhältnis zu den Gegentaktteilen nur sehr geringfügig verstärkt.

2.2.3.2. XY-Messungen

Wenn Drucktaste EXT X DEFL (S2) des Horizontalablenkungsschalters und einer des TRIG OR X DEFL-Schalters eingedrückt sind ist der Zeitablenkgenerator ausgeschaltet. Wenn beispielsweise Drucktaste A von S22 eingedrückt ist ein Signal das über Kanal A zugeführt wird kann nur zur Horizontalablenkung verwendet werden. Der Schalter AC/0/DC und der Stufenabschwächer von Kanal A bleiben wirksam.
Mit dem Einsteller X POSITION wird horizontale Bildverschiebung ermöglicht und mittels A AMPL/DIV kontinuierliche Einstellung des Ablenkkoeffizienten.

Für X Ablenkung kann auch der vertikale Kanal B verwendet werden.
In diesem Fall Taste B des TRIG OR X DEFL-Schalters eindrücken.

Es ist ferner möglich eine interne Spannung der Netzfrequenz, oder ein Signal angelegt an die EXT Buchse (Vorderseite rechts unten), für die X-Ablenkung zu verwenden. Zu diesem Zweck die betreffende Drucktaste des TRIG OR X DEFL-Schalters eindrücken.
In EXT und EXT ÷ 10 Betriebsarten kann die Bildbreite mit dem X AMPL/HOLD OFF Potentiometer eingestellt werden. Mit diesem Potentiometer in Stellung CAL, beträgt der Ablenkungskoeffizient für externe Signale 50 mV/Teil. Das externe Signal lässt sich durch Eindrücken der DC oder LF Taste der Triggerkopplungseinsteller der Hauptzeitablenkung entweder gleichspannungs- oder wechselspannungskoppeln (untere Frequenzgrenze 10 Hz).

2.2.2.3. AC/0/DC Schalter

Die zu beobachtenden Signale sind an die Buchse(n) A und/oder B zu legen und der AC/0/DC Schalter abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.
Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein, Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechselspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz- Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen.
Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

2.2.4. Triggerung

Wenn ein Signal dargestellt werden soll, muss, um ein stillstehendes Bild zu erhalten, die Horizontalablenkung stets an einem festen Punkt des Signals gestartet werden.
Der Zeitablenkgenerator wird folglich von in der Triggereinheit erzeugten schmalen Triggerimpulsen gestartet und durch ein Signal gesteuert das entweder den vertikalen Eingangssignalen, einer internen Netzfrequenzspannung oder einer externen Quelle entstammen kann.

2.2.4.1. Triggerkopplung

Mit Schalter DC/LF/HF kann man drei verschiedene Triggerkopplungsarten wählen. In den Stellungen HF und LF ist die Übertragungscharakteristik begrenzt.
In Stellung DC wird das Triggersignal unverändert durchgelassen.
In Stellung LF wird ein 0 Hz (7Hz bei externer Triggerung) bis 30 kHz Bandpass eingesetzt. Diese Stellung dient zur Verminderung von Störungen durch Rauschen.
In Stellung HF wird ein 30 kHz Hochpass eingesetzt. Diese Stellung kann zum Herabsetzen von Störungen durch Brummen verwendet werden.

2.2.4.2. Selektieren der Triggerquelle und Einstellen des Triggerpegels

Das Triggersignal kann von Kanal A (Taste A gedrückt), Kanal B (Taste B gedrückt), den COMP A und B Signalen (Tasten A und B gleichzeitig eingedrückt), von einer externen Quelle (Taste EXT oder EXT ÷ 10 gedrückt) oder von einer internen Spannung bei Netzfrequenz (Tasten EXT und EXT ÷ 10 gleichzeitig eingedrückt) entnommen werden.
Der Triggerimpulsformer ist ein zweifach gesteuerter Multivibrator, der von den Ausgangssignalen eines Differenzverstärkers gesteuert wird.
Das Triggersignal wird zusammen mit Vorspannungen die mit Potentiometer LEVEL einstellbar sind an die Eingänge des Differenzverstärkers gelegt.

Abhängig von der LEVEL Einstellung wird ein bestimmter Teil des Triggersignals durch den Differenzverstärker verstärkt.
Der Multivibrator ist somit auf einen fasten Punkt des Triggersignals geschaltet (Abb. 2.4.). Das bedeutet, dass es mit Hilfe des Einstellers LEVEL möglich ist die Form des Triggersignals abzutasten (bei interner Triggerung A oder B gleich der Form des darzustellenden Signals) und somit den Punkt zu wählen, an dem der Multivibrator umgeschaltet wird.
Der Potentiometer ist mit einem Zug-Druck-Schalter versehen, der die Wahl der Triggerflanke erlaubt.

2.2.4.3. Automatische Triggerung

Wenn Taste AUTO des AUTO-TRIG-SINGLE-Schalters gedrückt ist - und wenn keine Triggerimpulse vorhanden sind - ist der Zeitablenkgenerator automatisch freilaufend. Das Bild ist daher stets sichtbar. Die Stellung AUTO kann in allen Fällen verwendet werden in welchen auch Stellung TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit der "AUS"-Zeit über 100 ms.
Sobald Triggerimpulse vorhanden sind, wird der Freilauf des Zeitablenkgenerators automatisch beendet und der Zeitablenkgenerator erneut getriggert wie erwähnt in Abschnitt 2.2.4.1. und 2.2.4.2.
Wird Taste TRIG oder Taste SINGLE eingedrückt ist die Automatik ausgeschaltet. Einstellung LEVEL kann auch in Betriebsart AUTO benutzt werden.

2.2.4.4. SINGLE-SWEEP-Triggerung

Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden. Selbstverständlich muss der betreffende einzelne Sägezahn von einem Triggerimpuls getriggerd werden. Zu diesem Zweck Taste SINGLE eindrücken. Der erste Triggerimpuls , der nach Loslassen der gedrückten Taste erscheint, startet den Zeitablenkgenerator.
Der Zeitablenkgenerator wird dann blockiert bis Taste SINGLE wieder betätigt wird. Die Lampe NOT TRIG'D leuchtet auf sobald die Taste SINGLE eingedrückt ist, und bleibt leuchten bis der Triggerimpuls ankommt.

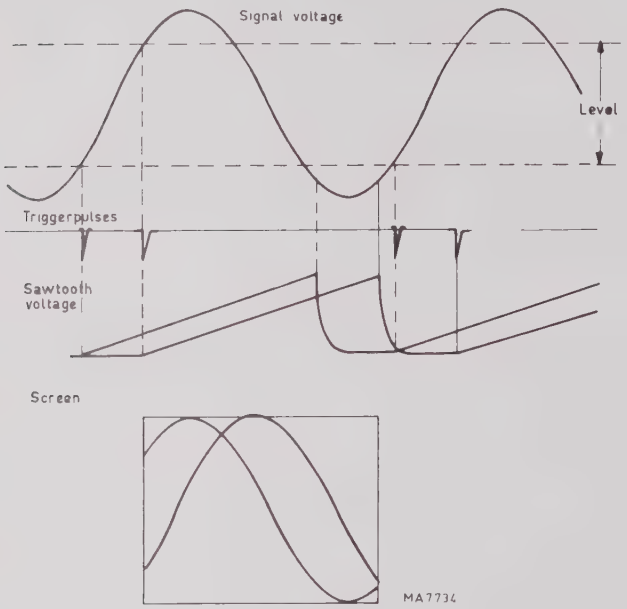


Abb. 2.4. Abtasten der Wellenform mittels des LEVEL Potentiometers

2.2.5. Dehnung der Zeitablenkung MAGN (R2/S3)

Die Dehnung der Zeitablenkung wird mit einem Zug-Druck-Schalter der an den Einsteller für horizontale POSITION gekoppelt ist, eingestellt. Wenn dieser Schalter in Stellung X10 gezogen ist wird ein 10 mal schnellerer Zeitmassstab des Hauptzeitablenkgenerators eingestellt. Folglich wird der Signalteil, welcher in der X1 Stellung (TB MAGN eingedrückt) über eine Breite von ein Teil (DIV) in der Schirmmitte dargestellt wird, in der X10 Stellung über die Gesamtbreite des Schirmes geschrieben.
Jeder Teil des Bildes kann mit dem horizontalen POSITION Einsteller zur genauen Beobachtung sichtbar gemacht werden.
In der X10 Stellung wird der Zeitkoeffizient durch Teilen des gegebenen Wertes TIME/DIV durch 10 ermittelt.

2.2.6. Gebrauch der verzögerten Zeitablenkung DTB

Die verzögerte Zeitablenkung kann zur genauen Beobachtung komplexer Signale verwendet werden. Sofort nach betätigung der Drucktaste MAIN TB der Triggerquelleneinsteller (S21) der verzögerten Zeitablenkung wird ein Teil des dargestellten Signals in Stellung MAIN TB des Horizontal-Ablenkungsschalters (S21) zusätzlich aufgehellt. Mit dem DELAY TIME Einsteller (R1) ist dieser zusätzlich aufgehellte Teile über die Zeitachse verschiebbar. Die Zeitdauer dieses zusätzlich aufgehellten Teils ist mit den Einstellern TIME/DIV des verzögerten Zeitablenkgenerators sowohl stufenweise wie stufenlos einstellbar. Mit Drucktaste DEL'D TB des Horizontalablenkungs-Schalters (S2) wird der zusätzlich aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht. In Stellung DEL'D TB, wird die Verzögerungszeit (dass heisst die Zeit zwischen dem Startpunkt der Hauptzeitablenkung und dem Startpunkt der verzögerten Zeitablenkung) bestimmt durch die Einstellungen des Schalters TIME/DIV der Hauptzeitablenkung und die des DELAY TIME Einstellers.
Wenn einer der Schalter der verzögerten Zeitablenk-Triggerquelle (S21) betätigt, dann startet der erste Impuls nach der gewählten Verzögerungszeit die verzögerte Zeitablenkung. Dieser Triggerimpuls wird von der Triggereinheit des verzögerten Zeitablenkgenerators geliefert.

Diese Stellung kommt zur Anwendung wenn durch Jitter eine undeutliche Darstellung zu beobachten ist. Dieses Jitter kann durch das beobachtende Signal selbst oder durch externe Dehnung in den Zeitablenkschaltungen entstehen.

2.2.7. Gebrauch der alternierenden Zeitablenkung ALT TB

Das PM 3266 ist mit Darstellungsumschaltung ausgerüstet. Diese Vorrichtung bietet dem Gebraucher gleichzeitige Darstellung des Signals an den beiden von der Hauptzeitablenkung und von der verzögerten Zeitablenkung zur Verfügung gestellten Zeitmassstäben.
Genauere Beobachtung eines bestimmten Abschnitts der Hauptzeitbasis-Darstellung wird durch Erweiterung des betreffenden Zeitintervalls mit Hilfe der verzögerten Zeitbasis ermöglicht. Durch Wahl einer entsprechend schnelleren Ablenkung für TIME/DIV der verzögerten Zeitbasis wird die Erweiterung erzielt. Mit Potentiometer DELAY TIME lässt sich die Positionierung des Zeitintervalls einstellen.
Der von der verzögerten Zeitbasis ausführlich zu beobachtende Teil des Signals bleibt ein aufgehellter Bildausschnitt der Hauptzeitbasis. Dies erleichtert nicht nur die Lokalisierung des gewünschten Details, wenn der Skalenpotentiometer (R1) gedreht wird, sondern dient auch als Sichtanzeige des zu betrachtenden Ausschnitts des Gesamtbildes. Mann kann auch sofort das Detail mit dem Signal, welches sehr complex sein kann, in Beziehung bringen, ohne dabei zwischen MAIN TB und DEL'D TB schalten zu müssen.
Mit TRACE SEP ist die Vertikalverschiebung zwischen den beiden Zeitbasen kontinuierlich einstellbar.

2.2.8. Gebrauch des dritten Kanal TRIGGER VIEW

2.2.8.1. Externe oder interne Triggerung

Bei zahlreichen Anwendungen, wie bei Triggerung mit digitalen Signalen oder mit Signalen von sehr unterschiedlichen Formen ist Anwendung einer externen Triggerquelle erforderlich damit eine einwandfreie Zeitbeziehung gewährleistet ist und um die Zeitbeziehung zwischen Triggersignal und Messsignal(en) zu kennen.
Durch Eindrücken der Taste TRIG VIEW wird das an Eingangsbuchse X7 gelegte externe Triggersignal als dritter Kanal dargestellt, mit der Schwelle nahe der horizontalen mittleren Rasterlinie. Durch Einstellung von LEVEL CONTROL (R7, S7) lässt sich leicht feststellen welcher Teil des Triggersignals die Ablenkung auslöst. Dies ist auch möglich bei intern von Kanal A oder Kanal B entnommen Signalen wenn Taste A oder B des Schalters S22 gedrückt ist.
Die Empfindlichkeitseinstellung der externen Triggerdarstellungsart hat zwei Stufen, 50 mV/Teil und 0,5 V/Teil. Mit Drucktastenschalter EXT (S22) eingedrückt ist der Ablenkfaktor 100 mV/Teil und somit ECL kompatibel. Bei Betriebsart EXT/10 (S22) ist der Ablenkfaktor 1 V/Teil und somit TTL kompatibel.

2.2.8.2. Einmalige Ablenkung

Mit Hilfe von LEVEL/SLOPE (R7, S7) lässt sich der Triggerpegel auf einen vorbestimmten Wert einstellen ohne dass ein Eingangssignal erforderlich wäre. Dies ist von Bedeutung wenn das zu messende Signal nicht im voraus vorhanden ist, wie beispielsweise bei der Prüfung von einzelner Vorgänge. Wenn Eingangssignale, die eine bekannte Schwelle überschreiten, dargestellt werden sollen, kann der Triggerpegel LEVEL CONTROL (R7, S7) im voraus eingestellt werden und ein Eingangssignal genügender Amplitude wird die Zeitablenkung auslösen.
Einstellung des Triggerpegels geschieht auf folgende Weise: Drucktaste TRIG VIEW eindrücken.
Das Bild mit Steller LEVEL (R7) soviele Teile in entgegengesetzter Richtung verlagern (bezogen auf die horizontale mittlere Rasterlinie) wie die Triggerschwelle erfordert.

Bemerkung: Die Triggerquelle ist definiert als der Abstand zwischen Triggerpunkt und Nullinie des Verstärkers (d.h. ohne Eingangssignale und ohne Ablenkung mittels Steller POSITION).

2.2.9. Bedienung der Speicherfunktionen

MEMORY OFF Betrieb

Wenn die Tasten STORE und WRITE gedrückt sind, ist die Speicherfunktion ausgeschaltet und arbeitet das Gerät als ein normales Oszilloskop. Mit dem Knopf INTENS wird die Helligkeit der dargestellten Signalform geregelt. Der Knopf FOCUS muss auf die maximale Schärfe der dargestellten Signalform eingestellt werden.

Sperren des Speichersystems. Wenn das Gerät in Betriebsart FAST (nach Ende des ERASE Zyklus) auf die Zeitablenkung wartet, kann das Gerät nur auf MEMORY OFF Betrieb gestellt werden und nicht auf WRITE oder STORE Betrieb Einstellung auf WRITE oder STORE Betrieb wenn beim FAST Betrieb der gesamte ERASE/WRITE Betrieb-Zyklus beendet ist; mit anderen Worten nur nach Ablauf der Zeitbasis und nachdem das Bild übertragen wurde.

ACHTUNG: Eine grosse Helligkeit über längere Zeit, vor allem im Betriebsart MEMORY OFF, kann die Elektronenstrahlröhre beschädigen.

WRITE Betrieb

Die Signalform wird mit normaler Geschwindigkeit geschrieben. Die Stellung des Knopfes INTENS bestimmt die Helligkeit der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Je nach Stellung des Knopfes PERSISTENCE wird entweder ein rasch verschwindendes Bild auf grünem Untergrund geschrieben (Steller gänzlich nach links gedreht) oder ein langsam verschwindende Leuchtspur auf schwarzem Untergrund (Steller berührt den ersten rechtsläufigen Anschlag). Bei Darstellung eines Niederfrequenzsignals kann PERSISTENCE so eingestellt werden, dass ein Flimmern des Bildes unterdrückt wird.
Bei einem signal mit niedriger Folgefrequenz und kurzer Anstiegszeit kann PERSISTENCE so eingestellt werden, dass die Schreibspur aufgefüllt wird damit eine deutliche und stabile Darstellung erzielt wird.
Die Schreibgeschwindigkeit lässt sich um einen Faktor von etwa 10 erhöhen wenn PERSISTENCE auf MAX gestellt wird.

FAST Betrieb

Die Signalform wird mit hoher Schreibgeschwindigkeit aufgezeichnet. Die Stellung des Knopfes INTENS bestimmt die Helligkeit der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform.
Diese Betriebsart ist ein Einmalbetrieb. Falls VIEW TIME nicht auf MAX steht wird der nächste Zyklus wiederholend ausgeführt. Das gespeicherte Bild wird gelöscht und danach wird, sobald die Zeitbasis getriggert ist, ein neues Bild geschrieben. Nach einer einstellbaren Betrachtungszeit beginnt der nächste Zyklus mit Löschung des Bildschirms.
Die Betrachtungszeit lässt sich mit Hilfe des Stellers VIEW TIME zwischen 3 Sekunden (Steller ganz nach links gedreht) und 8 Sekunden (Steller berührt den ersten rechtsläufigen Anschlag) einstellen.
Wenn Knopf VIEW TIME in Stellung MAX steht dann wird ein neues Bild erst dann aufgezeichnet wenn Taste ERASE gedrückt wurde. In dieser Betriebsart ist es auch möglich das Gerät nach Ablauf der Zeitbasis und nachdem ein neues Bild geschrieben wurde in STORE-Betriebe arbeiten zu lassen. Diese Funktion wird auf folgende Weise bewirkt. Das Gerät auf FAST und danach auf ERASE (Löschen des Bildes) stellen.

Das Gerät wartet nun auf ein Triggersignal. Jetzt Taste STORE eindrücken und das Gerät wird sich in STORE-Betrieb befinden, nachdem das neue Bild geschrieben wurde. Um eine gute Bildqualität zu erhalten darf die Wartezeit für das Triggersignal nicht länger als 1 Minute dauern.

STORE Betrieb

In dieser Betriebsart kann eine aufgezeichnete Signalform über längere Zeit gespeichert werden. Steller INTENS ist wirksam: wenn der Steller den ersten linksläufigen Anschlag berührt, ergibt dies eine lange Speicherzeit von etwa 1 Stunde. In dieser Stellung ist die Signalform nicht sichtbar. Wenn Steller INTENS ganz nach rechts gedreht ist ergibt dies kurze Speicherzeit. Für Werte siehe Abschnitt "Technische Daten". Die Signalform ist nun deutlich sichtbar. Drucktaste ERASE ist bei STORE-Betrieb nicht wirksam.

ERASE Betrieb

Wird die Strahlspur nicht mehr benötigt, dann kann sie durch Eindrücken der Taste ERASE (nicht wirksam bei STORE-Betrieb) gelöscht werden. Es kann vorkommen, dass die Strahlspur nicht gänzlich verschwindet besonders die mit beträchtlicher Helligkeit geschriebenen Teile. Dies lässt sich durch langzeitige Betätigung der Taste "ERASE" vermeiden.

Notice d'emploi

1. GENERALITES

1.1. INTRODUCTION

L'oscilloscope PM 3266 est du type portatif à grande vitesse d'écriture (1000 DIV/μs). Il permet de mesurer des signaux à haute sensibilité (2 mV/DIV) sur une largeur de bande étendue (100 MHz). L'oscilloscope est équipé de nombreux circuits intégrés qui garantissent un fonctionnement très stable et réduisent le nombre des points de réglage.
En vue du contrôle et du réglage, des points de test sont prévus en certaines positions appropriées autour du circuit. L'appareil présente plusieurs fonctions de mémorisation telles que vitesse d'écriture normale et rapide ainsi que l'effaçage automatique.
Un grand choix de modes d'affichage est possible: voie simple, deux voies alternées ou découpées, deux voies additionnées, en position normale et inversée pour un signal d'entrée et base de temps principale et retardée.
De plus, le PM 3266 présente une troisième voie TRIG VIEW et des possibilités de base de temps alternée.
TRIG VIEW permet l'affichage du signal de déclenchement (interne ou externe) par une troisième voie par l'intermédiaire d'un bouton-poussoir.
ALT.TB offre à l'utilisateur un affichage simultané du signal sur les deux échelles de temps par les bases de temps principale et retardée.
L'oscilloscope se caractérise par une alimentation à faible dissipation.
Cette unité d'alimentation fonctionne pour deux gammes de tension 90 V à 140 V et 200 V à 264 V; un commutateur permet ce changement, de sorte qu'il n'est pas nécessaire d'adapter l'appareil à la tension secteur locale.
Toutes ces caractéristiques donnent au présent oscilloscope une grande variétés d'application.

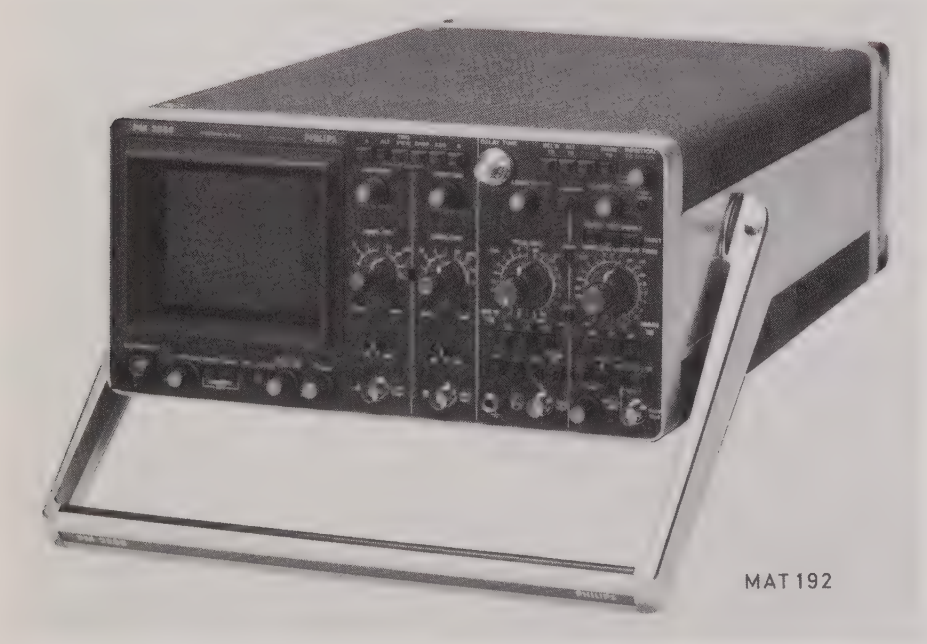


Fig. 1.1. Oscilloscope portatif double trace à mémoire PM 3266

1.2. CARACTERISTIQUES TECHNIQUES

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe I. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

Les spécifications sont valables aprés que l'appareil a été préchauffé pendant 30 minutes, Les valeurs exprimées numeriquement avec tolérance sont garanties par le fabricant. Les valeurs sans tolérance ne servent qu'á titre d'information et correspondent aux caractéristique d'un appareil moyen.

	Désignation	Spécification	Information supplémentaire
1.2.1.	**Tube à rayons catodiques**		
	Type	Philips L14-140GH/95	Tube à mémoire à grande vitesse d'ecriture, transfert l'image et agrandissement du balayage en sens vertical. Tube à face rectangulaire, post-accérateur couche phosphore doublée de métal.
	Aire de mesure	8x10 div.	1 div. = 0,9 cm.
	Type d'écran	Phosphore P31 (GH)	Les lignes droites verticales et horizontales se situeront dans l'aire centrale 7x9 div. de l'écran.
	Tension d'accélération totale	10 kV	
	Graticule	Interne	pas illuminé.
	Gravures	Pointillés à 1,5 et 6,5 Div. à partir du sommet de l'affichage permettent de verifier le temps de montée.	
	Vitesse d'écriture	1000 div/μs	En mode FAST. Pas garantie pour les aires carrées de 2 x 2 divisions dans chaque coin de l'écran.
		2,5 div/μs	En mode WRITE et position MAX
		0,25 div/μs	En mode WRITE
	Temps de mémoire	1 heure max	En mode STORE: en fonction de la commande INTENS (luminosité)
		60 sec.	En mode WRITE á intensité maximale.
		15 sec.	En mode MAX. WRITE á intensité maximale.
		15 sec.	En mode FAST à intensité maximale.
	Persistance	0,3 sec ... 1 min	Fonctionnel en mode WRITE Continûment variable.

Effacement automatique	Fonctionnel en mode FAST avec commande VIEW TIME hors position MAX. Temps de visualisation continûment variable entre 3 et 8 sec.	En mode d'effacement automatique le cycle suivant est réalisé: l'image mémorisée est effacée. Si la base de temps est déclenchée, une nouveau cycle démarre et l'image est effacée, etc. En mode FAST les boutons AUTO, TRIG et SINGLE sont hors service, leur fonction est reprise par l'umité de mémoire.
Temps d'effacement	1,3 sec en mode WRITE 1,6 sec en mode FAST	Les valeurs indiqées représentent le temps entre le relâchement du bouton ERASE et la fin de ce cycle Le bouton ERASE permet de remettre la base de temps principale à zéro.
Rotation de trace	Réglage par tournevis	Accessible par un des trous de ventilation côte gauche de l'appareil.

1.2.2. Axe vertical ou Y

1.2.2.1. Bande passante (gamme 2 mV exceptée)

Gamme de fréquence	continu à 100 MHz 7 Hz ... 100 MHz	–3 dB largeur de bande en couplage continu –3 dB largeur de bande en couplage alternatif La gamme de fréquence inclut une sonde 10:1 à 20-30 °C.
Temps de montée	3,5 ns	
Dépassement	± 4 % crête-à-crête	Sur 6 divisions, +5 - +40 °C

1.2.2.2. Coefficients de déviation

	2 mV/DIV ... 5 V/DIV	(pour spécifications en gamme 2 mV, se référer à la section 1.2.2.13.). En 11 positions étalonnées (progression 1-2-5) avec commande continue non-calibrée 1: ⩾ 2,5 par potentiomètre. Indication de non-calibrage par lampe.
Erreur limite	± 3 %	Sauf linéarité du tube à rayons cathodiques.
Tension d'entrée maximale admise	± 400 V 800 V_{cc} en alternatif	Tension continue + tension alternative crête Déviant à des fréquences supérieures à 500 kHz.
Déviation maximale sans distortion.	24 divisions	Jusqu'à 35 MHz
Gamme de décalage	16 divisions	8 divisions au-dessus et au-dessous de la ligne horizontale centrale du graticule.

Désignation	*Spécification*	*Information supplémentaire*
1.2.2.3. *Impédance d'entrée*	1MΩ (± 2%) //≈ 15pF	
Constante de temps RC d'entrée	22 ms	Commutateur de couplage en position AC.
1.2.2.4. *Instabilité*		(pour réglage 2 mV/DIV, se référer à 1.2.2.13.).
Instabilité de trace	0,1 div/heure	Gamme de température 20-40°C
Saut de trace	0,2 div	Lorsque l'on commute l'atténuateur entre deux positions.
Saut de trace	0,5 div	Lorsqu'on commute NORM/INVERT
Dérive de trace	0,2 div	Lorsqu'on tourne l'atténuateur continu 0,4 div en gamme 5 mV.
Dérive de trace	1 div	En poussant le bouton ADDED 0,4 div en gamme 5 mV. Croissante lorsqu'on tourne l'atténuateur continu.
1.2.2.5. *Dérive de température à court terme*	Identique à 1.2.2.6.	
1.2.2.6. *Dérive de température à long terme*	20 μV/°C	Valeur typique
1.2.2.7. *Retard visible du signal*	Environ 15 ns	
1.2.2.8. *Modes d'affichage*	Voie + ou – A seulement Voie + ou – B seulement Affichage déclenchement seulement Voies ± A et ± B découpées Voies ± A et ± B alternées Voies ± A et ± B additionnées Affichage déclenchement ± A et ± B découpées ou alternées (affichage 3 voies)	Si l'affichage 3 voies est sélectionné avec l'affichage base de temps alternée, l'ensemble est automatiquement affiché en mode de base de temps intensifiée Se référer à 1.2.2.12. pour specifications complètes de l'affichage déclenchement.
1.2.2.9. *Fréquence de commutation*	≈ 1 MHz	Temps d'affichage par voie: env. 350 ns
1.2.2.10. *Diaphonie entre voies*	1 : 500	Jusqu'à 50 MHz 8 divisions d'amplitude du signal sur une voie; diaphonie sur l'autre voie dans les limites du voie, jusqu'à 35 Mc.
1.2.2.11. *Facteur de réjection en mode commun*	Supérieur à 100 jusqu'à 2 MHz 20 à 50 MHz	En mode +A et –B additionnées signal max. en mode commun: 8 div.

	Désignation	*Spécification*	*Information supplémentaire*
1.2.2.12.	*Affichage déclenchement*		
	Affichage	Signal de déclenchement externe ou interne	
	Coefficient de déviation	Comme verticale	
	Externe	100 mV/div ± 3 %	
	Externe÷ 10	1 V/div ± 5 %	
	Interne	Vertical ± 10 %	
	Point de déclenchement	Centre d'écran ± 0,3 div; couplage continu	
	Aberrations	±10 % crête-à-crête	
	Retard de temps entre entrée verticale et entrée externe	3 ns ± 1 ns	
	Largeur de bande	80 MHz	Valeur typique
1.2.2.13.	*Spécification pour réglage 2 mV/div*		
	a. Coefficient de déviation	2 mV/div	
	Erreur limite	± 5 %	
	b. Réponse		
	Gamme de fréquence	Continu 0 ... 35 MHz	−3 dB
		alternatif 7 Hz ... 35 MHz	−3 dB
	Temps de montée	10 ns	
	Aberration d'impulsion	± 5 % crête-à-crête	
	Facteur de réjection en mode commun	meilleure que 100 à 2 MHz	
	c. Instabilité		
	Instabilité de trace	0,25 div/h	Gamme de température 20-40 °C
	Saut de trace	1 div	Lorsque l'on commute l'atténuateur de 5 à 2 mV
	Saut de trace	2 div	Lorsqu'on actionne le commutateur NORM/INVERT
	Dérive de trace	1 div	Lorsqu'on tourne l'atténuateur continu
	Dérive de trace	1 div	En poussant le bouton ADDED

1.2.3. Axe horizontal ou X

1.2.3.1.	*Modes de représentation*	– Base de temps principale	
		– Base de temps principale intensifée par base de temps retardée	
		– Base de temps retardée	Séparation de trace de 4 divisions possible
		– Base de temps intensifiée et base de temps retardée affichées alternativement	
		– Mode X-Y et X-Y/Y	Déviation X par: – le signal voie A – le signal voie B – le signal appliqué au connecteur EXT de la base de temps principale – la fréquence secteur.

	Désignation	*Spécification*	*Information supplémentaire*
1.2.3.2.	*Dérive horizontale en position X1*	0,2 div/h	La dérive horizontale avec agrandisseur en position X1 ne peut pas excéder 0,1 div/h dans la gamme de température 20-40 °C La même stabilité est requise au démarrage du balayage dont la vitesse est variée, sauf pour les gammes de balayage supérieures (50-100 ns/div).
1.2.3.3.	*Commande de la position horizontale*	± 5,2 div à partir du centre de l'écran	La commande de décadrage horizontal combine le réglage gros et le réglage fin.
1.2.4.	**Base de temps principale**		
1.2.4.1.	*Fonctionnements*	Déclenché Automatique Balayage unique	En automatique, la base de temps est en fonctionnement libre en l'absence de signaux de déclenchement après moins de 0,1 s.
1.2.4.2.	*Vitesses de balayage*	1 s/div ... 50 ns/div	En 23 positions étalonnées (progression 1-2-5) Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre Une lampe indiquant le non-calibrage des deux bases de temps.
1.2.4.3.	*Précision de mesure*	± 2 % ± 3 %	Entre +20 °C et +30 °C Entre + 5 °C et +40 °C Différence de précision de balayage pour toutes 2 divisions est de ± 5% à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.4.4.	*Expansion*		
	Agrandissement	10x	Commuté, étalonné. L'affichage coïncidant à la ligne de graticule horizontale centrale ne peut pas dévier de plus d'une division lors du réglage de l'agrandisseur horizontal sur X10.
	Erreur de coefficient	± 1 % supplémentaire	Premières et dernières 50 ns de 5 ns/div, 10 ns/div et 20 ns/div agrandis ± 5 %
	Coefficient de temps efficace maximal	5 ns/div	
1.2.4.5.	*Temps de blocage variable (hold off)*	Le temps de blocage du balayage peut être augmenté par un facteur 10.	
1.2.5.	**Base de temps retardée**		
1.2.5.1.	*Fonctionnement*	La base de temps retardée est déclenchée par la base de temps principale immédiatement après le temps de retard choisi ou par le signal à examiner après le temps de retard (absence de jitter).	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.5.2.	*Stabilité de comparateur à long terme*	< 2 div pour agrandissement 1000 fois	Avec base de temps principale 1 ms/div et retardée 1 µs/div, un détail de signal sélectionné en mode base de temps retardée ne bougera pas de plus de deux divisions après le pré-chauffage.
1.2.5.3.	*Vitesses de balayage*	0,5 s/DIV ... 50 ns/DIV	En 22 positions étalonnées (progression 1-2-5). Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre. Une lampe indiquant le non-calibrage des deux bases de temps.
1.2.5.4.	*Précision de mesure*	± 2 % ± 3 %	Entre +20 °C et +30 °C Entre + 5 °C et +40 °C Cette précision de balayage, mesurée toutes les deux divisions sur 10 DIV est de 5 %, à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.5.5.	*Retard*	Continuellement variable entre 0x et 10x le coefficient de temps de la base de temps principale.	Etalonné. Gamme de multiplicateur du temps de retard 0,00 - 9,99. Précision différentielle 0,5 %, typique 0,2 %.
1.2.5.6.	*Instabilité du retard*	1 : 20.000	
1.2.6.	**Deviation X**		
	Déviation X par Y_A ou Y_B	2 mV/div à 5 V/div	Commande continue non-étalonnée 1:2,5 par potentiomètre Y GAIN.
1.2.6.1.	*Erreur de mesure*	± 5 %	
1.2.6.2.	*Bande passante*	0 ... 2 MHz	–3 dB sur 4 DIV
1.2.6.3.	*Déviation maxi sans distortion*	20 divisions	Jusqu'à 100 kHz
1.2.6.4.	*Déphasage par rapport á l'affichage Y*	3° à 100 kHz	
	Déviation externe X par douille EXT		
1.2.6.5.	*Coefficient de déviation*		
	Ext. Ext. ÷ 10	50 mV/div 500 mV/div	Commande continue non-etalonnée 1:3
1.2.6.6.	*Précision Ext.*	± 3 %	2 % supplémentaire pour Ext.: 10.
1.2.6.7.	*Bande passante*	continu ... 2 MHz 7 Hz ... 2 MHz	par couplage de déclenchement DC par couplage de déclenchement LF ou HF
1.2.6.8.	*Caractéristique d'entrée*	mêmes que pour voies Y	
1.2.6.9.	*Déphasage*	3° à 100 kHz	
1.2.6.10.	*Linéarité*	1,5 %	
1.2.6.11.	*Dérive*	0,2 div/h	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.7.	**Déclenchement de la base de temps principale**		
1.2.7.1.	*Source*	Interne à partir de la voie A Interne à partir de la voie B Composite A et B Interne à partir du secteur Source externe	 Mode vertical alterné uniquement
1.2.7.2.	*Modes*	Automatique	Fonctionnement automatique du générateur de base de temps environ 100 ms après la disparition du signal de déclenchement.
		Balayage simple	La lampe NOT TRIG'D est allumée après rèmise à zéro et s'éteint en fin de balayage.
1.2.7.3.	*Polarité*	+ ou –	
1.2.7.4.	*Sensibilité*	Internal: 0,5 div. jusqu à 1,5 div à 100 MHz	Sensibilité typique en fonction de la fréquence
		external: 50mV jusqu à 150 mV à 100 MHz	Sensibilité typique en fonction de la fréquence
		external ÷ 10 : 500 mV	
1.2.7.5.	*Bande passante du filtre*	DC: 0 - bande totale LF interne: 0 - 30 kHz LF externe: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz AUTO: 20 Hz - bande totale	Réponse uniforme, en interne et en externe –3 dB –3 dB –3 dB, interne et externe
1.2.7.6.	*Gamme de niveau*		
	Déclenchement interne Déclenchement externe Externe÷ 10	24 DIV +1,2 V à –1,2 V + 12 V à – 12 V	
1.2.7.7.	*Caractéristique d'entrée*	1MΩ (± 2%)//≈15pF	
1.2.7.8.	*Instabilité de déclenchement*	< 0,5 ns	
1.2.8.	**Déclenchement de la base de temps retardée**		
1.2.8.1.	*Source*	Interne à partir de la voie A Interne à partir de la voie B Externe	Les autres caractéristiques à celles mentionnées au paragraphe 1.2.7. DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE, à l'exception de Ext.÷ 10 et du déclenchement secteur.
1.2.9.	**Unité d'étalonnage**		
1.2.9.1.	*Tension de sortie*	3 V_{cc}	
1.2.9.2.	*Courant de sortie*	6 mA	
1.2.9.3.	*Erreur limite*	± 1 %	Tension et courant
1.2.9.4.	*Fréquence*	2 kHz ± 2 %	
1.2.9.5.	*Protection*	La sortie est protégée contre des courts-circuits même continus.	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.10.	**Entrées/sorties arrière**		
1.2.10.1.	*Modulation Z*	Couplé en continu Compatible TTL Polarité positive Affichage supprimé Temps de réponse 35 ns Impédance d'entrée 10 kOhm Tension maximale d'entrée 50 V	
1.2.10.2.	*Porte base de temps principale*	0 ... +5 V délivrée pendant le balayage de base de temps principale	En option Impédance de sortie 1 kOhm
1.2.10.3.	*Porte base de temps retardée*	0 ... +5 V délivrée pendant le balayage de base de temps retardée	En option Impédance de sortie 1 KOhm
1.2.11.	**Alimentation**		
1.2.11.1.	*Tensions secteur*	90 - 140 V alternatif 200 - 264 V alternatif 250 - 350 V continu	Protégé automatiquement contre le réglage incorrect du sélecteur secteur
1.2.11.2.	*Fréquence secteur*	46 à 440 Hz	
1.2.11.3.	*Consommation*	50 W	
1.2.11.4.	*Transitoire secteur*		Dans des conditions de transitoire tension et fréquence spécifiée dans MIL-T-28800, l'oscilloscope ne subira aucun dommage.

1.2.12. Conditions ambiantes

Les données relatives aux conditions ambiantes ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation Philips de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

1.2.12.1. Tests de température

Conformément à CEI 68 Ab et Bb.
Gamme de référence d'utilisation: +5 °C ... +40 °C
Gamme limite d'utilisation: –15 °C ... +55 °C. Les exceptions aux tolérances sont indiquées par spécification
Conditions de stockage et de transport: –55 °C ... +75 °C.

1.2.12.2. Altitude

Conformément à CEI 68-2-13, test M.
En fonctionnement: 5000 m
Déviation: 1 °C/300 m pour température maximale
Hors fonctionnement: 17000 m.

1.2.12.3. Chocs

30 g, demi-sinus, durée 11 ms; 2 chocs par axe dans chaque direction, total 12 chocs.

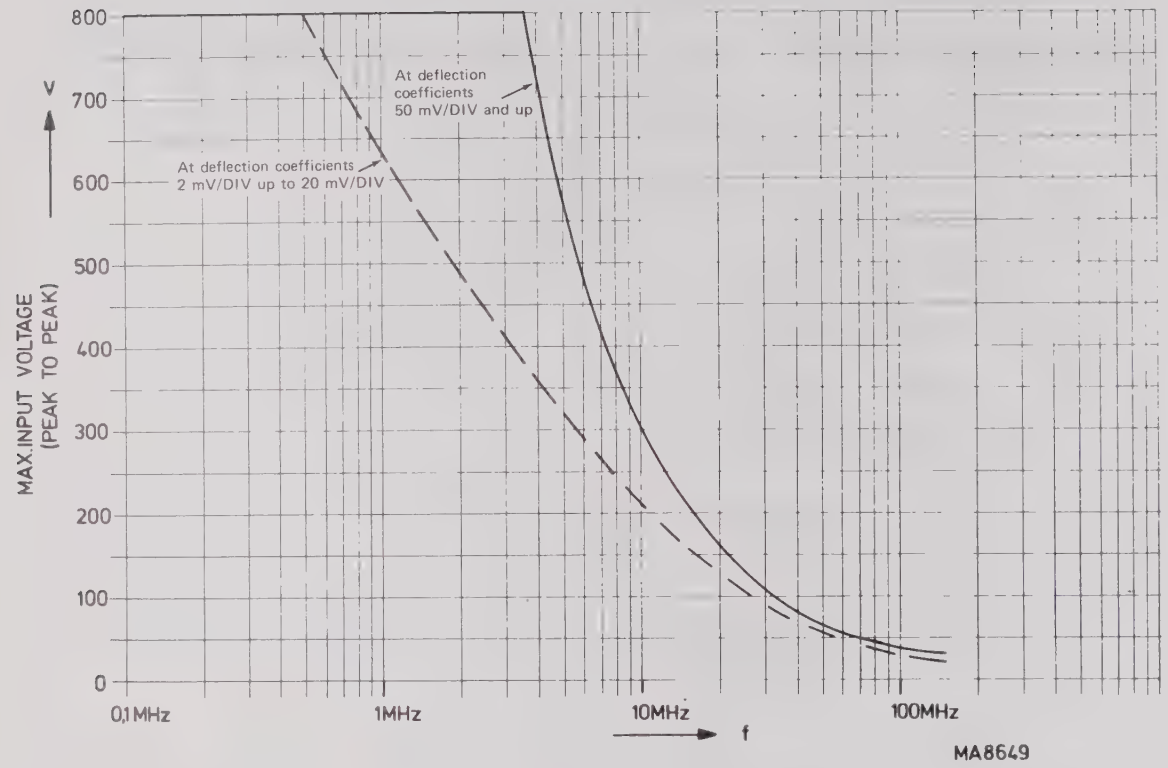


Fig. 1.2. Réduction de la tension d'entrée maximale admise

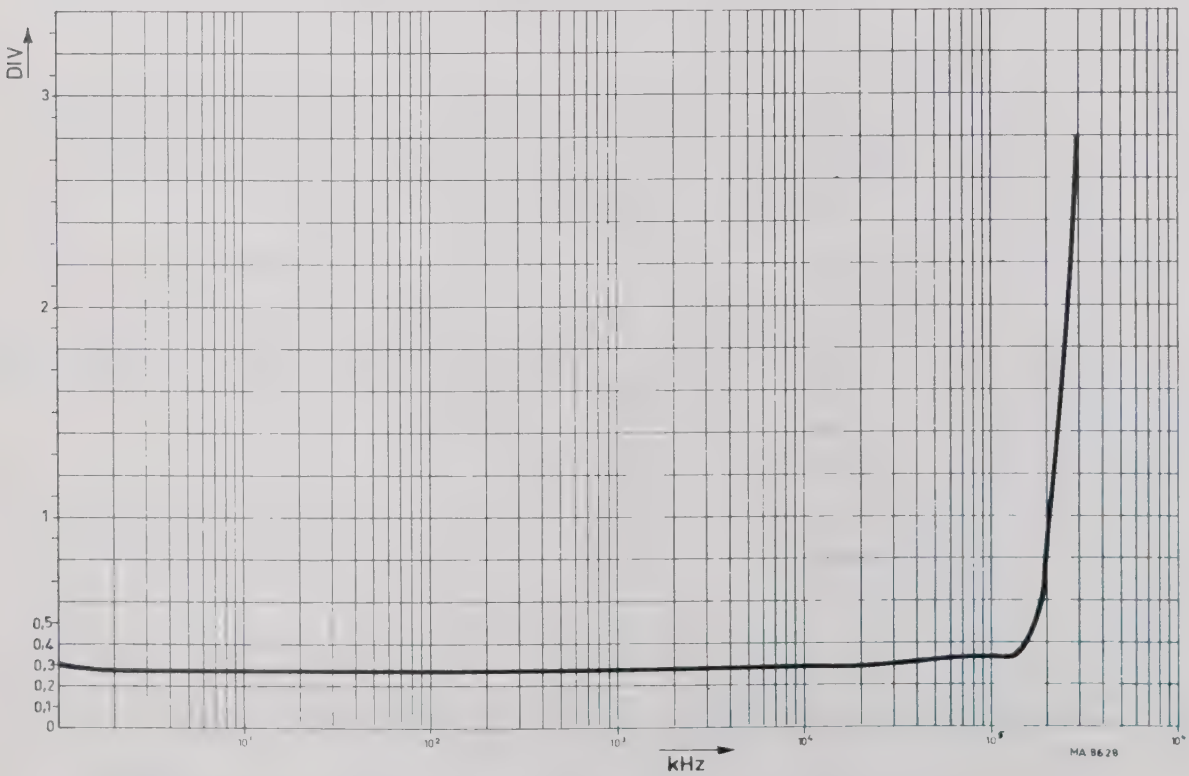


Fig. 1.3. Sensibilités typiques pour déclenchement interne et externe à partir de la voie A

Désignation	*Spécification*	*Information supplémentaire*

1.2.12.4. *Vibration*

En fonctionnement: 15 min. dans chacune des trois directions.

0,7 mm déplacement crête-à-crête (4g à 55 Hz) à fréquence 10 Hz - 55 Hz - 10 Hz en cycles d'une minute.

1.2.12.5. *Temps de rétablissement*

30 minutes si la température de l'instrument passe de −10 °C à +20 °C sous humidité relative de 60 %.

1.2.12.6. *Blindage magnétique*

Conformément à CEI 351-22.3.1.
Déviation maxi: 1 div.

1.2.12.7. *Interférence électromagnétique*

Conformément à VDE 0871 et 0875, Störgrad K.

1.2.13. Caractéristiques mécaniques

1.2.13.1. *Dimensions*

Longueur	460 mm	Commandes, couvercle et pieds non compris
Largeur	316 mm	
Hauteur	154 mm	

1.2.13.2. *Poids* 10,9 kg

1.3. ACCESSOIRES

1.3.1. Accessoires livrés avec l'appareil

- Deux sondes passives 10:1
- Filtre de contraste
- Couvercle frontal avec emplacement pour accessoires
- Visière pliante PM 9366
- Adaptateur BNC banane PM 9051
- Borne CAL - Adaptateur BNC
- Notice d'emploi et d'entretien.

1.3.2. Accessoires en option

PM 8921	Sonde 1:1, câble 1,5 m
PM 8921L	Sonde 1:1, câble 2,5 m
PM 8935	**HF** Sonde 10:1, câble 1,5 m
PM 8935L	**HF** Sonde 10:1, câble 2,5 m
PM 8932	Sonde 100:1
PM 8994	Jeu d'accessoires pour sondes
PM 9353	Sonde FET active 1:1, 10:1, 100:1, 3,5 pF (1.5 m)
PM 9355	Sonde de courant 1 mA/div ... 1 A/div 12 Hz ... 70 MHz
PM 9346	Alimentation de sonde
PM 8960	Jeu pour montage en rack 19''
PM 8992	Sacoche pour accessoires
PM 9380	Appareil de photographie d'oscillogrammes
PM 8971	Adapteur de caméra pour PM 9380
PM 8910	Filtre Polaroid
PM 8980	Visière longue
PM 8901	Jeu de batteries 24 V continu et 280 V continu
PM 8991	Chariot

Les caméras Steinheil Oscillophot (R): M3, M4 et M5 sont applicables à condition d'utiliser l'adaptateur Steinheil 1820/50.

Fig. 2.1. Dépose du couvercle frontal

Fig. 2.2. Vue arrié de l'appareil

2. Mode d'emploi

2.1. GENERALITES

La présente section décrit les travaux et précautions requises à l'installation du PM 3266. De plus, elle décrit en bref les fonctions des commandes et indicateurs, et met en évidence les aspects practiques du fonctionnement. De la sorte; un opérateur peut rapidement se familiariser avec les fonctions principales de l'appareil.

2.1.1. Installation

Avant de procéder à toute autre connexion, la borne de terre de l'appareil doit être reliée à la ligne de terre du réseau (voir mise à la terre).

REMARQUE: L'ouverture des capots ou la dépose d'organes, à l'exception de ceux directement accessibles à la main sont susceptibles de mettre à jour des composants et des connecteurs sous tension.

L'appareil doit être débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d'entretien ou une réparation demandant l'ouverture de l'appareil.
Au cas où le réglage, l'entretien ou la réparation de l'appareil ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.
Ne pas oublier que les condensateurs à l'intérieur de l'appareil peuvent être chargés, même si l'appareil est déconnecté de toute source de tension.

2.1.2. Démontage et montage du couvercle frontal

Démontage:
- Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED).
- Enlever le couvercle.

Montage:
- Tourner le bouton de verrouillage vers position UNLOCKED
- Fixer le couvercle sur la partie avant de l'oscilloscope.
- Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

Remarque: Pour faire pivoter la poignée, il faut enfoncer les boutons-poussoirs aux étriers.

2.1.3. Adaptation à la tension secteur et fusible

La capacité d'utilisation à toute tension secteur comprise entre 90 V et 140 V (taux de tension mentionné visible sur CIRCUIT BREAKER) et entre 200 V et 264 V (connexion inversée également visible par une fenêtre à l'arrière) supprime la nécessité d'adapter l'appareil à la tension secteur locale dès que l'alimentation correspondante a été établie.
Le porte-fusible monté sur le panneau arrière porte un fusible à action retardée de 2 A. S'assurer que des fusibles correctement calibrés et du modèle convenable sont utilisés en cas de remplacement. Il faut éviter d'utiliser des fusibles réparés et de court-circuiter des porte-fusibles. En cas de remplacement d'un fusible l'appareil doit être débranché de toutes sources de tension.

Remarque: Pour le réglage 90 ...140 V ainsi, que 200 V ... 264 V, le même fusible lent 2 A est utilisé.

2.1.4. Mise à la terre

Avant toute mise sous tension, l'appareil doit être connecté à la terre de l'une des manières suivantes:
- Par la borne de terre de l'appareil (symbole ⏚).
- Par le cordon secteur à trois conducteurs.

La fiche secteur ne doit être introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre. Le remplacement d'une fiche secteur se fait aux risques et périls de l'utilisateur.

ATTENTION: Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.
Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

2.1.5. Enclenchement

Le commutateur POWER est incorporé dans la commande INTENS (panneau avant), juste sous le bord de l'écran. La lampe POWER ON/OFF est adjacente à la commande INTENS.
L'oscilloscope ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé . Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'oscilloscope.

2.2. UTILISATION

Avant d'enclencher, l'appareil, s'assurer qu'il est installé conformément à la section 2.1. INSTALLATION et que les précautions requises ont été prises.

2.2.1. Commandes et prises (Fig. 2.3.)

2.2.1.1. Voies verticales

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Commandes du mode d'affichage vertical; sélecteur à 6 boutons-poussoirs.
Poussoir A enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie A.
Poussoir ALT enfoncé	L'affichage est permuté d'une voie verticale à l'autre, et ce à la fin de chaque cycle du signal de base de temps; par ex. les voies A et B sont représentées sur les balayages ALT.
Poussoir TRIG VIEW enfoncé	L'affichage est commuté pour visualiser le signal de déclenchement sélectionné. Il peut être interne par les voies A ou B (A ou B de S22 enfoncé) ou externe par la douille d'entrée externe X7 (EXT ou EXT ÷ 10 de S22 enfoncé).
Poussoir CHOP enfoncé	L'affichage est permuté d'une voie verticale à l'autre à une fréquence fixe, les deux voies étant affichées sur le même balayage.
Poussoir ADD enfoncé	La déviation verticale est obtenue par la somme des signaux A et B.
Poussoir B enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie B.
Toutes les poussoirs relâchés	Si aucun bouton-poussoir n'est enfoncé, l'appareil fonctionne en mode ALT.
Poussoirs ALT et TRIG VIEW enfoncés simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés pendant les balayages alternés; normalement appropriés pour des signaux haute fréquence. (Voir aussi explication bouton-poussoir TRIG VIEW)
Poussoirs CHOP et TRIG VIEW enfoncés simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés successivement à la fréquence CHOP pendant le même balayage, normalement appropriés pour des signaux basse fréquence. (Voir aussi explication bouton-poussoir TRIG VIEW).
POSITION (R3, R4)	Commande continûment variable pour décadrage vertical de l'affichage.
PULL TO INVERT (S4, S5)	Commutateur tirette intégré à la commande POSITION, pour inversion de la polarité du signal. La polarité est inversée en position tirée.
AMPL/DIV (S9, S11)	Commande échelonnée à 11 positions des coefficients de déviation verticale.
CAL AMPL/DIV (R8/S10, R9/S12)	Commande continuellement variable des coefficients de déviation verticale. En position CAL. le coefficient de déviation est étalonné.
UNCAL (V4, V5)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
GAIN (R12, R13) (accessible par tournevis)	Commande continuellement variable du gain des voies verticales.

AC, 0, DC (S17, S18)	Mode de couplage du signal d'entrée; commutateur à trois positions.
AC enfoncé	Couplage par l'intermédiaire d'un condensateur de liasion.
0 enfoncé	La connexion entre l'entrée de l'amplificateur et la prise d'entrée est interrompue et l'entrée de l'amplificateur est mise à la terre.
DC enfoncé	Couplage direct. Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton AC est enfoncé. Pour visualiser des impulsions de longue durée ou des niveaux continus, il faut sélectionner DC. Pour des ondes alternatives avec importants niveaux continus, il faut sélectionner AC.
A 1MΩ - 15 pF (X3)	Prise d'entrée BNC pour voie A.
B 1MΩ - 15 pF (X4)	Prise d'entrée BNC pour voie B.

2.2.1.2. Voie horizontale

DEL'D TB, ALT TB, EXT. X DEFL, MAIN TB (S2)	Commandes du mode d'affichage horizontal; par commutateur à boutons-poussoirs.
Poussoir DEL'D TB enfoncé	La déviation horizontale est fournie par le générateur de base de temps retardée.
Poussoir ALT TB enfoncé	L'affichage horizontal est permuté de base de temps principale en base de temps retardée à la fin de chaque cycle du générateur de base de temps principale.
Poussoir EXT. X DEFL enfoncé	La déviation horizontale peut être obtenue par un signal d'origine extérieure appliqué à la prise d'entrée (X7) de l'amplificateur horizontal, par le signal de voie A, par le signal de voie B, par le signal composite, ou par un signal à la fréquence du secteur en fonction de la sélection TRIG ou X DEFL (S22).
Poussoir MAIN TB enfoncé	La tension de déviation horizontale est fournie par le générateur de base de temps principale. Une partie de la trace est intensifiée (sauf en position OFF du commutateur TIME/DIV du générateur de base de temps retardée) **Si aucun bouton n'est enfoncé,** on obtient le même effet que lorsque le bouton MAIN TB est enfoncé.
POSITION TB MAGN (R2, S3)	Commande continuellement variable pour le positionnement horizontal des traces; cette commande comprend un commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 10.
MAGN (V3)	Une lampe témoin indiquée X10 s'allume lorsque cette loupe est utilisée.
X AMPL, HOLD -OFF (R18)	Commande continuellement variable des coefficients de déviation horizontale dans le cas de déviation par un signal extérieur. Dans le case de déviation X par la base de temps principale, cette commande peut être utilisée pour augmenter le temps de blocage du balayage.
TRACE SEP. (R6); (commande tournevis)	Commande de pré -réglage continûment variable de l'espace vertical entre les deux affichages de base de temps en mode ALT TB.

2.2.1.3. Générateur de base de temps principale

LEVEL SLOPE (R7, S7)	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps principale démarre. Cette commande comprend un commutateur push-pull, qui permet de déclencher sur le front positif ou négatif du signal de déclenchement (enfoncé +, tiré –).
NOT TRIG'D (V2)	Lampe témoin qui s'allume lorsque le générateur de base de temps principale est en position d'attente.
AUTO, TRIG, SINGLE	Commande de mode de déclenchement; commutateur à trois boutons-poussoirs.
Poussoir AUTO enfoncé	Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.
Poussoir TRIG enfoncé	Le générateur de base de temps est déclenché normalement.
Poussoir SINGLE enfoncé	Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulse de déclenchement. Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.
TIME/DIV or DELAY TIME (S15)	Commande de la vitesse de balayage de la base de temps principale; commutateur rotatif à 23 positions.
CAL (bleu) - TIME/DIV (R11, S16)	Commande continuellement variable de la vitesse de balayage de la base de temps principale. (En position CAL, la vitesse de balayage est étalonnée).
UNCAL (V6)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
DC, LF, HF (S20)	Choix du couplage de déclenchement: commutateur à 3 positions.
DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par le filtre passe-bas pour des fréquences allant jusqu'à 30 kHz (de 7 Hz à 30 kHz pour déclenchement externe, par filtre passe-bande).
HF	Couplage par un filtre passe-haut pour des fréquences supérieures à 30 kHz. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la touche DC était enfoncée.
TRIG or X DEFL	Commutateur à 4 boutons-poussoirs qui permet de sélectionner ou la source de déclenchement ou la déviation X par une source extérieure. Déviation X seulement si le bouton-poussoir EXT X DEFL de S2 (commandes de mode d'affichage horizontal)
Poussoir A enfoncé	Signal de déclenchement interne ou de déviation X provenant de la voie A.
Poussoir B enfoncé	Signal de déclenchement interne ou signal de déviation X provenant de la voie B.
COMP (A et B enfoncés simultanément)	Signal de déclenchement interne ou signal de déviation X provenant des voies A et B.
EXT	Déclenchement par un signal externe appliqué à la prise adjacente 1 MOhm - 15 pF (X7). Lorsque le bouton EXT X DEFL des commandes de déviation horizontale est enfoncé, cette prise est connectée à l'entrée de l'amplificateur horizontal.
EXT ÷ 10	Déclenchement externe ou déviation X comme pour EXT mais atténué du facteur 10.

LINE (EXT et EXT ÷ 10 enfoncé simultanément)	Signal de déclenchement ou de déviation X provenant d'une tension interne à la fréquence du secteur. Si aucun bouton n'est enfoncé, aucun mode n'est sélectionné.
1 MOhm - 15 pF (X7)	Prise BNC pour déclenchement externe ou déviation horizontale.

2.2.1.4. Générateur de base de temps retardée

DELAY TIME MULTIPLIER (R1)	Commande continuellement variable du temps de retard, utilisée en association avec les commandes TIME/DIV du générateur de base de temps principale.
LEVEL-SLOPE (R5, S6)	Commande continuellement variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement (enfoncé +, tiré –).
TIME/DIV (S13)	Commande du coefficient de temps pour base de temps retardée; commutateur rotatif à 23 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclencé.
CAL (bleu) TIME/DIV (R10, S14)	Commande continuellement variable du coefficient de temps de la base de temps retardée, En position CAL, le coefficient de temps du commutateur est étalonné.
UNCAL (V6)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
DC, LF, HF (S19)	Couplage de déclenchement; commutateur à 3 boutons-poussoirs.
DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par un filtre passe-bas pour les fréquences jusqu'à 30 kHz (pour le déclenchement par un signal exterieur, le filtre passe-bas agit de 7 Hz à 30 kHz).
HF	Couplage par un filtre passe-haut pour fréquences supérieure à 30 kHz. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton DC était enfoncé.
A, B, EXT, MAIN TB (S21)	Commande de la source de déclenchement; commutateur à 4 boutons-poussoirs.
A	Signal de déclenchement interne prélevé de la voie A.
B	Signal de déclenchement interne prélevé de la voie B
EXT	Déclenchement par application d'un signal externe à la douille adjacente 1 MOhm - 15 pF.
MAIN TB	La base de temps retardée démarre immédiatement après le temps de retard. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
1 MOhm - 15 pF (X6)	Prise d'entrée BNC pour le signal de déclenchement externe.

2.2.1.5. Tube à rayons cathodiques

INTENS/POWER ON — Commutateur secteur ON/OFF: en circuit, la diode LED est allumée.
En mode (MAX) WRITE, FAST ou MEMORY OFF: la position du bouton détermine l'intensité de l'onde écrite sur la couche mémoire du TRC.
En mode STORE: la position du bouton détermine la luminosité de l'onde reproduite sur l'écran TRC. Le temps de mémoire diminue en fonction de la luminosité croissante.

STORE/WRITE/FAST/ERASE/ MEMORY OFF — Bouton-poussoir pour commande du système de mémoire.

- STORE — Permet de mémoriser une onde pour visualisation prolongée. La commande INTENS est fonctionnelle.
- WRITE — Permet d'enregistrer une onde à vitesse d'écriture normale. Les commandes PERSISTENCE et INTENS sont fonctionnelles.
- FAST — Permet d'enregistrer une onde à grande vitesse d'écriture. Les commandes VIEW TIME et INTENS sont fonctionnelles.
- ERASE — Permet d'effacer l'onde écrite sur la couche mémoire du TRC. Cette commande n'est pas fonctionnelle en mode STORE.
- MEMORY OFF — Lorsque les boutons STORE et WRITE sont enfoncés simultanément la fonction mémoire du TRC est mise hors service.

Si une combinaison erronée de boutons est utilisée, l'appareil fonctionne en mode STORE.

PERSISTENCE/VIEW TIME — Cette commande permet, en mode WRITE, de retenir de façon variable l'onde enregistrée (persistance variable). La position MAX résulte en une vitesse d'écriture croissante (environ 10 fois supérieure). Le TRC présente une certaine illumination de fond. En mode FAST, l'effacement automatique et l'enregistrement d'une nouvelle image a lieu après un certain temps. Ce temps est déterminé par la position du bouton VIEW TIME.
En position MAX de ce bouton, l'enregistrement d'une nouvelle image n'a lieu qu'après avoir enfoncé le bouton ERASE. Le TRC présente une certaine illumination de fond.

FOCUS — Commande continûement variable de focalisation du faisceau électronique TRC dans le sens horizontal.
La focalisation verticale dépend de la commande INTENS. Elle est exacte pour pratiquement toute la gamme. Pour les positions extrêmes de INTENS, la focalisation verticale est réglable à l'aide d'un potentiomètre accessible par un trou de ventilation côte gauche de l'appareil. La plus grande vitesse d'écriture (mode FAST) n'est possible que si la focalisation du faisceau est optimale.

TRACE ROT (R15) — Commande de pré-réglage pour aligner la trace avec les lignes de graticule.
Par tournevis, accessible par un trou de ventilation côte gauche de l'appareil.

2.2.1.6. Divers

CAL (X1, X2) — Prise de sortie sur laquelle une tension rectangulaire de 3 Vcc et un courant de 6 mA sont disponibles à une fréquence de 2 kHz à des fins d'étalonnage.

(X5) — Douille de terre de mesure.

Z-MOD (X8) à l'arrière — Douille d'entrée pour modulation Z externe.

2.2.2. Réglages préliminaires

Etant donné que les réglages suivants sont identiques pour les deux voies verticales, seul le processus pour la voie A est décrit.
Sauf indications contraires, les commandes occupent la même position que pour le processus de réglage précédent.

2.2.2.1. Réglage du gain

- Actionner le bouton-poussoir A du sélecteur de mode de déclenchement (S22).
- Actionner le bouton-poussoir A des commandes de mode d'affichage (S1).
- Actionner le bouton-poussoir MAIN TB des commandes de déviation horizontale (S2).
- Centrer la trace avec la commande POSITION appropriée.
- Régler les commandes INTENS et FOCUS afin d'obtenir une trace nette et fine.
  Les commandes non-mentionnées peuvent occuper n'importe quelle position.
- Régler le commutateur AC-0-DC sur DC.
- Régler le commutateur AMPL sur .5 V et la commande continue sur CAL (étalonnée).
- Connecter la prise d'étalonnage CAL à la prise d'entrée A.
- Vérifier si la hauteur de trace est exactement de 6 divisions.
  Au besoin, rajuster la commande GAIN sur le panneau avant, juste sous le commutateur AMPL.

2.2.3. Entrées A et B et leurs possibilités

L'oscilloscope est pourvu de deux voies identiques, toutes deux pouvant être utilisées soit pour des mesures YT avec un ou deux générateurs de base de temps, soit pour des mesures XY avec la voie horizontale externe.

2.2.3.1. Mesures YT

Pour afficher un signal d'une des voies verticales, il suffit d'actionner le bouton-poussoir A ou B des commandes de mode d'affichage vertical.
Lorsque le bouton-poussoir ALT ou CHOP est enfoncé, deux signaux différents peuvent être affichés simultanément. Le coefficient de déviation Y et la polarité peuvent être sélectionnés pour chaque voie séparément. Lorsque le bouton ALT est actionné, l'affichage est commuté d'une voie à l'autre au retour du signal de base de temps.
Quoique le mode ALTERNATE puisse être utilisé à toutes les vitesses de balayage du générateur de base de temps, le mode CHOPPED donne une meilleure qualité d'affichage pour longs temps de balayage. En effet, pendant les temps de balayage longs, l'affichage alterné des deux signaux d'entrée est visible.

En mode CHOPPED, l'affichage est permuté d'une voie à l'autre à une fréquence fixe.
Si le bouton-poussoir ADDED du commutateur de mode d'affichage est actionné, les signaux des deux voies verticales sont additionnés. En fonction des positions des commutateurs de polarité, la somme ou la différence des signaux d'entrée est affichée. Le mode ADDED permet également des mesures différentielles.
Lorsque les commutateurs de polarité des deux voies sont mis en positions opposées, les parties mode commun des signaux aux prises A et B subissent une très légère amplification par rapport aux parties de mode différentiel.

2.2.3.2. Mesures XY

Si les bouton-poussoirs EXT X DEFL S2 des commandes de déviation horizontale et une des commandes TRIG OR X DEFL sont actionnés, les générateurs de base de temps sont déconnectés. Si par exemple le bouton-poussoir A de S22 est enfoncé, un signal appliqué à la voie verticale A est alors utilisé pour la déviation horizontale. Le commutateur AC/0/DC et l'atténuateur par échelons de la voie A restent en service. Le décadrage horizontal est possible à l'aide de la commande X POSITION et la commande continue des coefficients de deflection avec A AMPL/DIV.

La voie verticale B peut également être utilisée pour la déviation X. Pour ce faire, le bouton B des commandes TRIG OR X DEFL doit être enfoncé.
Pour la déviation X, il est également possible d'utiliser une tension interne à la fréquence secteur ou un signal extérieur appliqué à la douille EXT située sur la partie inférieure droite du panneau, après avoir enfoncé le bouton-poussoir correspondant des commandes TRIG OR X DEFL. Dans ces modes, la largeur de trace peut être commandée avec le potentiomètre X DEFL/HOLD OFF.
Lorsque ce potentiomètre est en position CAL, le coefficient de déviation pour un signal extérieur est de 50 mV/DIV.
Le signal externe peut être couplé en continu ou en alternatif (fréquence inférieure 7 Hz) en enfonçant le bouton DC ou LF des commandes de déclenchement de la base de temps.

2.2.3.3. Commutateur AC/0/DC

Les signaux observés sont appliqués aux prises d'entrées A et/ou B et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.
Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

2.2.4. Déclenchement

Lorsqu'un signal doit être représenté, la déviation horizontale doit toujours être démarrée à un point fixe du signal, et ce afin d'obtenir une trace stationnaire. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans l'unité de déclenchement et commandé par un signal qui peut provenir: d'un des signaux appliqués aux entrées verticales, d'une tension interne à la fréquence du secteur, ou d'une source extérieur.

2.2.4.1. Couplage de déclenchement

Trois méthodes de couplage de déclenchement sont possibles avec le commutateur DC/LF/HF. En positions HF et LF, la caractéristique de transfert est limitée.
En position DC, le signal de déclenchement reste inchangé.
En position LF, un filtre passe-bande de 0 Hz (7 Hz pour déclenchement externe) à 30 kHz est incorporè
Cette position peut être utilisée pour réduire l'interférence du bruit.
En position HF, un filtre passe-haut de 30 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interférence du ronflement par exemple.

2.2.4.2. Sélection de la source de déclenchement et réglage du niveau de déclenchement

Le signal de déclenchement est obtenu à partir de la voie A (bouton A enfoncé), de la voie B (bouton B enfoncé) des signaux composites A et B (A et B enfoncés simultanément), d'une source externe (bouton EXT ou EXT ÷ 10 enfoncé) ou d'une tension interne à la fréquence secteur (boutons EXT et EXT ÷ 10 enfoncés).
Le conformateur d'impulsions de déclenchement est un multivibrateur à double commande commuté par les signaux de sortie d'un amplificateur différentiel.
Le signal de déclenchement, est appliqué aux entrées de l'amplificateur différentiel de concert avec les tensions continues réglables avec le potentiomètre LEVEL.
En fonction du réglage LEVEL, une certaine partie du signal de déclenchement est amplifiée par l'amplificateur différentiel.
Le multivibrateur est donc commuté à un point fixe du signal de déclenchement (voir Fig. 2.4.). Ceci signifie que, s'aidant de la commande LEVEL. il est possible de donner sa forme au signal de déclenchement (en cas de déclenchement interne A ou B égal à la forme du signal à représenter) et donc, de choisir le point où le multivibrateur sera commuté.
Le potentiomètre LEVEL est pourvu d'un commutateur push-pull qui permet la sélection de la pente de déclenchement.

2.2.4.3. Déclenchement automatique

Lorsque le bouton AUTO du commutateur AUTO-TRIG-SINGLE est enfoncé, et qu'aucune impulsion de déclenchement n'est disponible, le générateur de base de temps fonctionne librement.
La trace est alors toujours visible. Le mode AUTO peut être utilisé dans tous les cas où le mode TRIG est également applicable, à l'exception de signaux dont la fréquence est inférieure à 10 Hz et de trains d'impulsions ayant un temps supérieur à 100 ms.
Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre du générateur de base de temps est automatiquement achevé et le générateur est à nouveau déclenché comme décrit aux paragraphes 2.2.4.1. et 2.2.4.2.
Lorsque les boutons TRIG ou SINGLE sont actionnés, le circuit automatique est mis hors circuit. Le réglage LEVEL peut également être utilisé en mode AUTO.

2.2.4.4. Déclenchement du balayage en SINGLE

Lorsque des effets uniques sont observés (par photographie), il faut s'assurer qu'une seule dent de scie est engendrée, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question. Il va de soi que la dent de scie simple en question doit être déclenchée par une impulsion de déclenchement. Pour ce faire, le bouton SINGLE doit être enfoncé. La première impulsion de déclenchement apparaissant après le relâchement du bouton démarre le générateur de base de temps. Celui-ci est alors bloqué jusqu'à ce que le bouton SINGLE soit enfoncé à nouveau. La lampe NOT TRIG'D s'allume dès que le bouton SINGLE est enfoncé et reste allumé et ce jusqu'à la fin de la dent de scie.

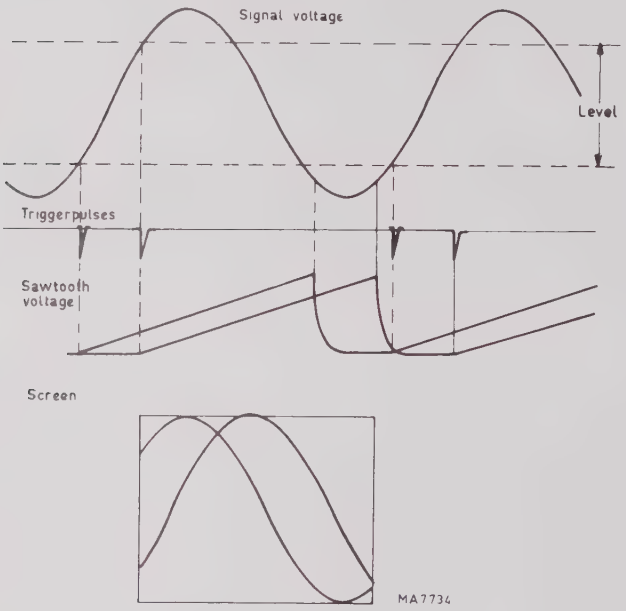


Fig. 2.4. Analyse de la forme d'onde à l'aide du potentiomètre LEVEL

2.2.5. Agrandisseur de base de temps MAGN (R2/S3)

L'agrandisseur de base de temps est actionné par un commutateur push-pull à deux positions incorporé dans la commande POSITION horizontale. Lorsque ce commutateur est tiré en position X10, les vitesses de balayage du générateur de base de temps principale sont augmentées d'un facteur 10. Donc, en X1, (TB MAGN enfoncé) la portion du signal affichée sur une largeur égale à une division au centre de l'écran occupe la largeur totale de l'écran en position X10. Chaque portion de la trace peut être rapportée sur l'écran à l'aide de la commande de POSITION horizontale.
En position X10, le coefficient de temps est déterminé en divisant par 10 la valeur TIME/DIV.

2.2.6. Utilisation de la base de temps retardée

La base de temps retardée peut servir à l'étude précise de signaux complexes. Lorsque le bouton-poussoir MAIN TB des commandes de la source de déclenchement (S21) de la base de temps retardée est actionné, la base de temps retardée est en service (par ex. commutateur TIME/DIV en position OFF), une portion de signal représenté est intensifiée en position MAIN TB des commandes de déviation horizontale (S2). La commande DELAY TIME permet de décaler cette partie intensifiée le long de l'axe des temps. La durée de cette portion intensifiée ainsi que sa longueur peuvent être commandées par échelons et ce de façon continue à l'aide des commandes TIME/DIV du générateur de base de temps retardée. Lorsque le bouton-poussoir DEL'D TB des commandes de déviation horizontale est enfoncé, la portion intensifiée occupe la largeur totale de l'écran.
En position DEL'D TB, le retard (c.à.d. l'intervalle entre le point de démarrage de la base de temps principale et le point de démarrage de la base de temps retardée) est déterminé par les réglages des commandes TIME/DIV principales et de la commande DELAY TIME.

Au cas où une des autres commandes de la source de déclenchement (S21) est actionnée, la base de temps retardée est demarrée par la première impulsion de déclenchement apparaissant après le temps de retard sélectionné. Cette impulsion est délivrée par le générateur de base de temps retardée.

Cette impulsion de déclenchement est produite par l'impulsion de déclenchement du générateur de base de temps retardée. Cette position est utilisée pour éviter une instabilité de la base de temps, laquelle donne une représentation floue d'un détail. Cette instabilité peut faire partie du signal à analyser ou, pour des agrandissements extrêmes, être produite dans les circuits de base de temps.

2.2.7. Utilisation de la base de temps alternée (S2)

Le PM 3266 est équipé d'une commutation d'affichage. De ce fait, l'utilisateur obtient un affichage simultané du signal sur les deux échelles de temps, l'un provenant de la base de temps principale et l'autre de la base de temps retardée.
Une portion de l'affichage de la base de temps principale peut être examinée en détail en allongeant l'intervalle de temps en question à l'aide de la base de temps retardée. Cette expansion est obtenue en sélectionnant un balayage plus rapide de la commande TIME/DIV de la base de temps retardée. Le positionnement de l'intervalle de temps est réglée par le potentiomètre DELAY TIME. La portion de signal détaillée par la base de temps retardée demeure portion intensifiée de l'affichage de base de temps principale. Ceci ne facilite pas seulement le détail lors du réglage, mais il sert aussi d'indication visuelle. L'observateur peut comparer directement le détail avec le signal total (peut être très complexe) sans devoir commuter entre MAIN TB et DEL'D TB.
Le décadrage vertical entre les deux affichages de base de temps est continûment variable à l'aide de la commande TRACE SEP (R6)

2.2.8. Utilisation de la troisième voie TRIGGER VIEW

2.2.8.1. Déclenchement externe ou interne

Dans la plupart des applications telles que le déclenchement des signaux numériques ou de forme différente, il faut utiliser une source de déclenchement externe assurant des relations de temps appropriées et permettant de comparer le signal de déclenchement aux signaux de mesure. Lorsque le bouton-poussoir TRIG VIEW est enfoncé, le signal de déclenchement externe à la douille d'entrée X7 est affiché en tant que troisième voie avec le seuil approchant la ligne de graticule centrale horizontale. Avec la commande LEVEL/SLOPE (R7, S7) il est facile de déterminer quelle partie du signal de déclenchement démarre le balayage. Ceci est également possible pour des signaux internes de la voie A ou B en enfonçant le bouton-poussoir A ou B du commutateur S22.

La commande de sensibilité du mode TRIG VIEW externe présente deux échelons à savoir 100 mV/DIV et 1 V/DIV.
Lorsque le bouton-poussoir EXT (S22) est enfoncé, le facteur de déviation est de 100 mV/DIV, ce qui est compatible aux niveaux ECL.
En mode EXT/10 (S22), le facteur de déviation est de 1 V/DIV, ce qui est compatible aux niveaux TTL.

2.2.8.2. Déclenchement monocoup

La commande LEVEL/SLOPE (R7, S7) permet de régler le niveau de déclenchement sur une valeur pré-déterminée sans signal d'entrée. Ceci est d'importance lorsque le signal à mesurer n'est pas disponible à l'avance, par exemple lorsque du test de phénomènes uniques. Si des signaux d'entrée dépassant un seuil connu doivent être représentés, le niveau de déclenchement peut être réglé à l'avance (R7, S7) et un signal d'entrée d'amplitude suffisante démarre le balayage de base de temps.
Le procédé de réglage du niveau de déclenchement a lieu comme suit: Enfoncer le bouton-poussoir TRIG VIEW. Positionner la trace à l'aide de LEVEL (R7) autant de divisions en sens opposé nécessaires au seuil de déclenchement requis.

Remarque: Le seuil de déclenchement est défini comme la distance entre le point de déclenchement et la ligne zéro de l'amplificateur (par exemple sans signaux d'entrée et déviation à l'aide des commandes position).

2.2.9. Utilisation des fonctions de mémoire

Mode MEMORY OFF

Lorsque les boutons STORE et WRITE sont enfoncés, la fonction de mémoire est mise hors service et l'appareil fonctionne comme un oscilloscope normal. Le bouton INTENS commande la luminosité de l'onde affichée. De plus, le bouton FOCUS doit être réglé sur netteté maximale de l'onde affichée.

Blocage du système de mémoire. Si l'appareil est en position d'attente en mode FAST (après le cycle ERASE), pour balayage de base de temps, l'instrument ne peut être utilisé qu'en mode MEMORY OFF et pas en mode WRITE ou STORE. L'instrument peut être mis en mode WRITE ou STORE si le cycle complet effacement/écriture est terminé. En d'autres mots seulement après fonctionnement de la base de temps et réalisation du transfert d'image.

ATTENTION: En position MEMORY OFF, spécialement en EXT X DEFL, une trop forte intensité pendant un certain temps peut endommager le TRC.
L'onde est enrigistrée à vitesse normale. La position de la commande INTENS détermine l'intensité de l'onde écrite sur la couche memoire du TRC

Mode WRITE

En fonction de la position du potentiomètre PERSISTENCE, une trace à disparition rapide est écrite sur fond vert (bouton en position extrême gauche) et une trace à disparition très lente sur fond noir (bouton en position "premier arrêt droite"), La persistance peut être réglée de telle sorte que tout clignotement est supprimé à la représentation d'un signal basse fréquence. Pour un signal à faible taux de répétition et court temps de montée, la persistance peut être réglée pour remplir la trace et donc obtenir une représentation nette et constante. La vitesse d'écriture peut être accrue d'un facteur 10 en mettant la commande PERSISTENCE en position MAX.

Mode FAST

L'onde est enregistrée à grande vitesse d'écriture. La position de la commande INTENS détermine l'intensité de l'onde écrite sur la couche mémoire du TRC.
Il s'agit d'un mode monocoup. Si la commande VIEW TIME n'est pas en position MAX, le cycle suivant est réalisé à répétition. L'image mémorisée est effacée et une nouvelle image écrite lorsque la base de temps est déclenchée. Après un temps de visualisation réglable, le cycle suivant commence à effacer l'écran TRC. Ce temps est réglable à l'aide de la commande VIEW TIME, entre 3 secondes (position extrême gauche) et 8 secondes (premier arrêt droit). Si le bouton VIEW TIME est en position MAX, l'enregistrement d'une nouvelle image n'a lieu qu'après que le bouton ERASE ait été enfoncé. Dans ce mode, il est également possible du choisir le mode STORE après fonctionnement de la base de temps et écriture d'un nouvelle image.
Pour cette fonction, procéder comme suit: mettre l'instrument en mode FAST et effacer l'image.
Ensuite, l'appareil attend un signal de déclenchement.
Enfoncer le bouton STORE et l'appareil est en mode STORE après l'écriture d'une nouvelle image.
Pour obtenir une image de bonne qualité, un signal de déclenchement devra être donné dans la minute.

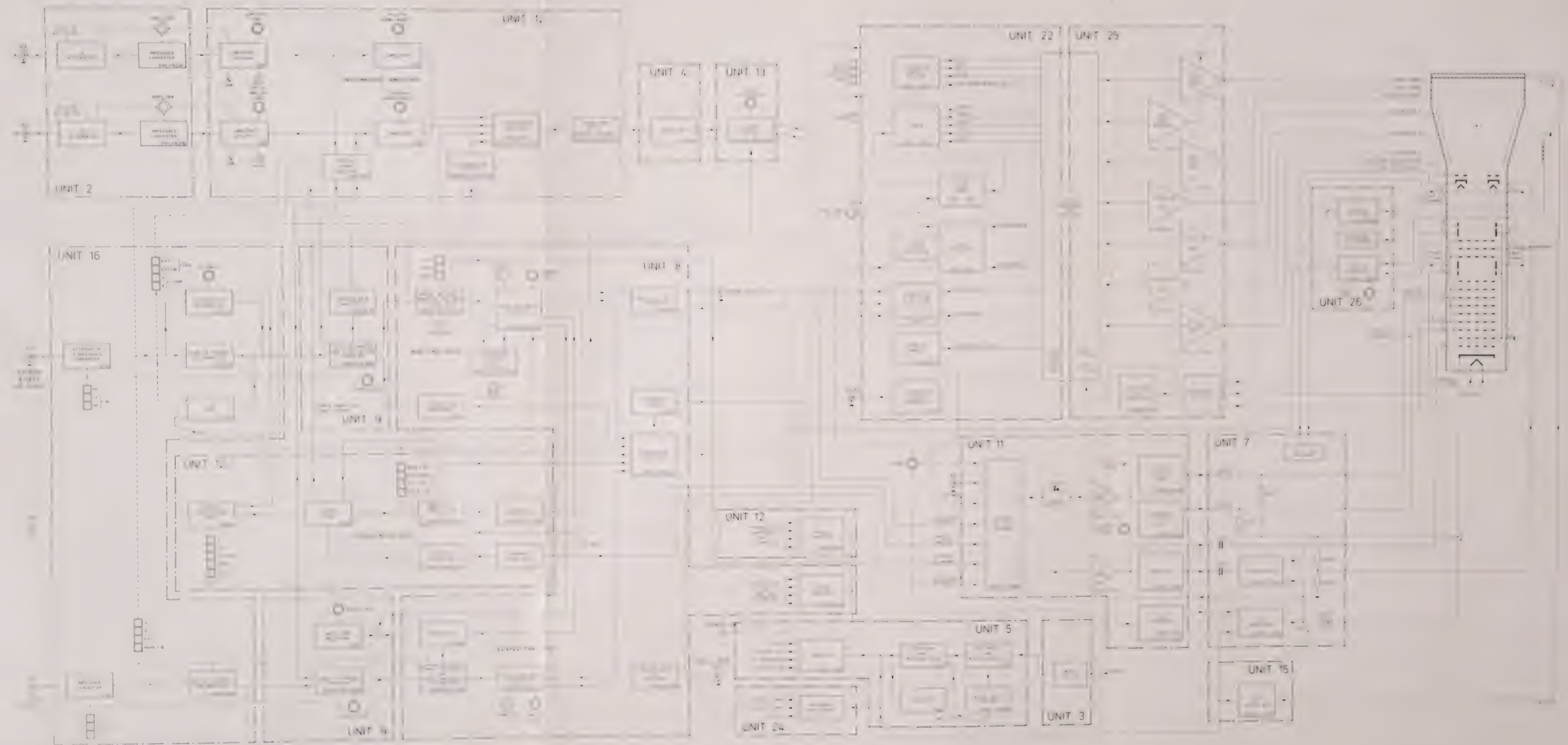
Mode STORE

Ce mode permet de mémoriser une onde enregistrée pour un temps prolongé. La commande INTENS est fonctionnelle: la commande sur le premier arrêt gauche donne un long temps de mémorisation (env. 1 heure). L'onde n'est pas visible dans cette position.
Avec la commande INTENS en position extrême droite, le temps de mémorisation est court: voir figures au chapitre "Caractéristiques". Dès lors l'onde est bien visible.
Le bouton ERASE n'est pas fonctionnel en mode STORE.

Mode ERASE

Lorsque la trace n'est plus nécessaire, elle peut être effacée en enfonçant le bouton ERASE (pas fonctionnel en mode STORE). Il se peut que la trace n'ait pas disparu entièrement et plus particulièrement les parties affichées avec luminosité substantielle. Ceci peut être corrigé avec un appui prolongé sur le bouton ERASE.

Service manual


UNIT 1
UNIT 2
UNIT 4
UNIT 13
UNIT 22
UNIT 25
UNIT 26
UNIT 16
UNIT 8
UNIT 9
UNIT 10
UNIT 12
UNIT 11
UNIT 7
UNIT 5
UNIT 15
UNIT 3
UNIT 24
UNIT 6

3. Service manual

3.1. DESCRIPTION OF THE BLOCK DIAGRAM

3.1.1. General information

The block diagram is shown in Fig. 3.1.

The PM 3266 oscilloscope comprises the following parts:

- a dual-channel vertical system
- a main time-base
- a delayed time-base
- a display-mode logic stage
- an X-amplifier
- a Z-stage
- a c.r.t. circuit
- the storage section
- a stabilized power supply

3.1.2. Dual-channel vertical system

Both vertical channels contain identical circuits. An input signal to one of the channels is, via a coupling switch AC/0/DC, applied to the input attenuator. In the AC position of the coupling switch there is a capacitor in the signal path. In the DC position the coupling is direct.
If the coupling switch is set to the 0 position, the connection between the input socket and the attenuator input is interrupted, the latter being earthed.

The input attenuator, which is controlled by the AMPL switch, enables the adjustment of the vertical-deflection sensitivity in calibrated steps.

The attenuator is followed by a low-drift impedance converter which gives the input circuit a high input impedance.
The impedance converter also contains a voltage divider which works in conjunction with the input attenuator.

The signal that leaves the impedance converter is applied to a balanced amplifier (D201-Y_A, D301-Y_B) where it is transformed into a push-pull signal. The balanced amplifier has two outputs. From one of these outputs the signals are applied to a trigger selector stage and from the other one to an amplifier stage (D202-Y_A, D302-Y_B).
This stage comprises the switch NORMAL/INVERT by means of which the phase of the signal can be inverted, and the controls for vertical trace positioning.

The following stage is a channel selector which either blocks or passes the signal as dicated by the vertical display-mode logic and switches.
In the A, B, ADD and TRIG VIEW modes the channel selector is set by means of voltage levels (via the display-logic stage) and in the ALT and CHOP mode controlled by pulses (also via the display-mode logic stage). In the ALT mode those pulses are supplied by the sweep-gating multivibrator of the main time-base generator during the fly back of the sweep, so that alternately the complete signals of channel A, channel B and the 3rd channel TRIG VIEW are displayed.
In the CHOP mode the drive pulses are provided by an oscillator which works at a fixed frequency of approximately 1 MHz.
Those pulses cause the electronic switches in the display-mode logic stage to be successively opened and closed so that successively part of the signal of channel A, channel B and the 3rd channel TRIG VIEW are displayed.

After the channel selector, the following circuits are common to the vertical channels.
A delay line that delayes the vertical signals to such an extent that the steep leading edges of fast signals are still displayed, a delay line driver stage and a final output stage which feeds the signals to the vertical-deflection plates.

3.1.3. Time bases

3.1.3.1. Main time-base

The M.T.B. trigger and X-Deflection amplifier receives its signal from one of the vertical channels or both (COMPOSITE), from the attenuator/impedance converter for external trigger or X deflection signals, or from the power supply (MAINS). One of those signals can be selected by operating one of the controls incorporate in this stage.

From this stage the signal is fed to either the X-Deflection amplifier for horizontal deflection, or the sweep-gating logic for starting the time-base generator. The MTB trigger and X-Deflection amplifier is a differential one, containing the controls for trigger-level adjustment, slope selection and coupling (i.e. DC/LF/HF) selection.

The slope selector allows the polarity of the trigger signal to be inverted, enabling triggering on the positive as well as on the negative slope of the input signals.

The sweep-gating logic starts and stops the time-base generator which delivers the sawtooth signal required for normal time-base operation. The generator comprises the charging capacitors and resistors selected by the TIME/DIV switch in order to set the time coefficients in calibrated steps. Continuous control of the time coefficients is obtained by varying the charging current of the time determining capacitors by means of the TIME/DIV continuous potentiometer.

The amplified output signal of the time-base generator is fed to the X deflection selector, the comparator which is part of the delayed time-base unit and via a feedback loop to the hold-off circuit. The hold-off circuit resets circuit resets the sweep-gating flip-flop (D901) and blocks its input during the flyback of the sawtooth signal. The hold-off circuit also incorporates the single-sweep circuit.

The three modes of operation of the main time-base are determined by the three-position switch AUTO/TRIGG/SINGLE.
In the AUTO mode, the automatic free-run circuit is operative when triggering pulses are absent. Thus a trace, though not necessarily a stationary one, is always displayed even though the trigger controls may not be correctly adjusted. In this way, correct adjustment of the oscilloscope trace is greatly facilitated. However, when trigger pulses are present the circuit reverts to the normal triggered mode. If trigger pulses disappear, the time-base free-runs after a lapse of approx. 100 ms. In the TRIGG. mode, a display is present only when suitable trigger pulses are available.
In the SINGLE mode, events that occur only once can be observed and photographed if necessary. It is often desirable to ensure that only one sweep is generated, even though other trigger pulses might follow the phenomenon of interest. In this mode, after the trigger pulse has initiated the main time-base to produce one sweep, the circuit is unaffected by further trigger pulses until it is reset for the next event by operating the reset push-button.

3.1.3.2. Delayed time-base

The delayed trigger-circuit and delayed time-base generator comprise in principle the same circuitry as the main trigger-circuit and main time-base generator. The delayed time-base works always in the single-shot mode. It is started by the main time-base generator which also serves as hold-off circuit for the delayed time-base.

The DELAY TIME multiplier control, the comparator and the reset multivibrator determine the delay time for the delayed time-base generator.

When push-button MAIN TB of the horizontal deflection mode controls has been depressed, the part of the trace coinciding with the delayed sweep is intensified, except in the OFF position of the delayed TIME/DIV switch.

3.1.4. X-Deflection selector

The X-deflection selector couples the external X-deflection signal, the output signal of the main time-base generator, the output signal of the delayed time-base generator or the combined output signals of the main and delayed time-base generators via the X-final amplifier, to the horizontal-deflection plates. The X-final amplifier comprises the horizontal trace positioning and 10x magnification controls.

The "alt-" and "chop"- mode stages supply blanking pulses to the Z amplifier. "Alt" pulses blank the trace at the end of the sweep of the main time-base and provide an extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. "Chop" pulses suppress the trace during the switching from channel Y_A to channel Y_B and/or the 3rd channel TRIG VIEW.

3.1.5. Storage system

3.1.5.1. Introduction

The PM 3266 oscilloscope is equipped with a special type of storage tube with an extremely high writing speed. The electrode configuration of this tube is shown in the block diagram. The high writing speed is achieved by a triple-mesh storage system:

- a collector mesh (G10)
- a fast storage mesh (G11)
- a front mesh (G12)

The flood gun system in the c.r.t. uses three collimator electrodes C1, C2 and C3.

In addition to the storage system, the c.r.t. has a scan magnifier (G7), which is located between the vertical and horizontal deflection plates.
This magnifier gives a x1.8 increase of vertical gain.
The scan magnifier gives a divergence of the electron beam in the vertical direction and a convergence in the horizontal direction. To correct for this, the c.r.t. has two focusing electrodes: G3 for horizontal focus and G5 for vertical focus.
The focusing function is also correctively influenced by the setting of the INTENS control, so that the spot on the c.r.t. screen remains weill-focused over the whole range of the intensity.

The block diagram description of the c.r.t. display section can be conveniently divided into the following sections:

- storage electrode systems with applied waveforms in the WRITE, FAST, STORE and MEMORY OFF modes;
- block diagram description of storage logic and storage amplifiers;
- block diagram description of the focus and Z-amplifier section.

3.1.5.2. Storage Electrode System

The storage cathode-ray is of the triple-mesh type. A fast mesh has been added between the collector mesh and storage mesh of the conventional storage tube. This fast mesh is characterised by a fast writing speed and short storage time. In the FAST writing speed mode, the information is written into the fast mesh and is transferred to the front mesh immediately after the end of the time-base sweep. This information transfer is aided by the flood beams and by pulsing the front storage mesh.

After this "image transfer", the fast storage mesh potential is increased to approximately that of the collector and the fast information is visible on the screen with the normal storage time.

The voltage waveforms applied to the storage electrodes in the WRITE MODE, FAST MODE, STORE MODE and NON - STORE MODE are now described. The voltages that are mentioned are typical values; the precise values are referred to in the section on Checking and Adjusting.

3.1.5.3. Write Mode

As the fast storage mesh (G11) is not used in this mode, it is connected to approximately the same potential as the collector mesh, as shown in Fig. 3.2.
This figure also indicates the voltage waveforms that are applied to the other electrodes.
During the erase cycle, the front mesh (G12) is first connected to a potential of 500 V for 100 ms (the first erase pulse) and then returned to approximately 0 V for 500 ms.
The erase cycle is then completed by applying the front mesh to approximately 10 V for 600 ms (the second erase pulse). After this, the front mesh is again returned to 0 V and can then be written afresh.

During the erase cycle the collimators C1 and C3 and the flood gun accelerator are pulsed in a positive direction.
The cycle described is a static erase cycle. It starts after the release of the ERASE pushbutton. In the MAX WRITE mode the 0 V levels are increased to a slightly positive value.
However, in the VARIABLE PERSISTENCE position an adjustable rapidly vanishing trace is required. To achieve this, dynamic erase pulses are applied to the front mesh as shown in Fig. 3.2. These pulses have an upper level of about +8 V, a frequency of about 100 Hz and an adjustable duty cycle. This duty cycle is adjustable between 0 and 30 % by means of the PERSISTENCE control; at 0 % the trace persists for some time (unless the ERASE pushbutton is operated) and at 30 % the trace rapidly disappears.

A time-base blocking signal is also shown in Fig. 3.2. The time-base is blocked from the beginning of the first erase pulse until 100 ms after the end of the second erase pulse. During this period the time-base does not respond to trigger signals.

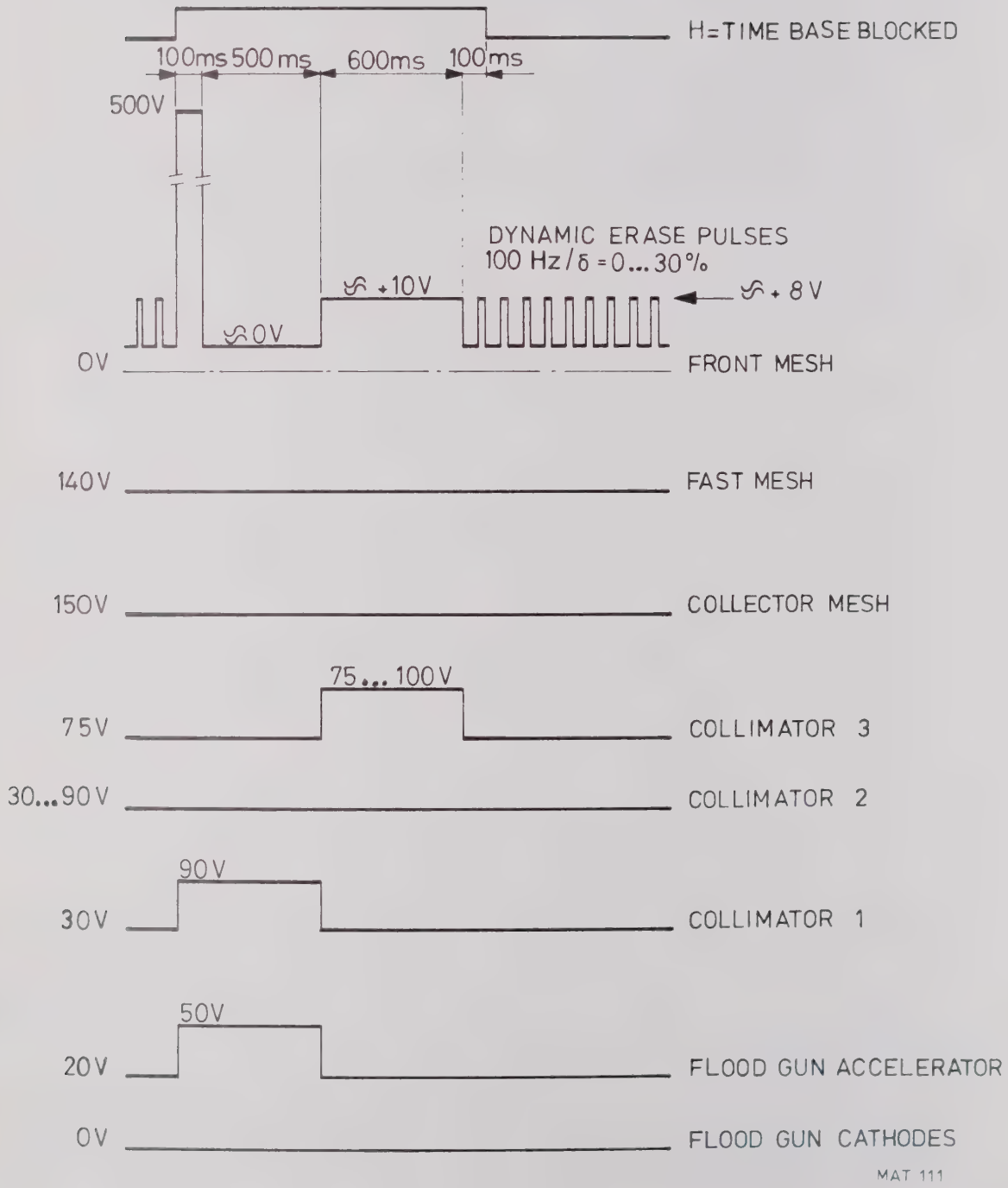


Fig. 3.2. Voltage wave forms applied to the storage electrodes of the CRT in the WRITE mode.

3.1.5.4. FAST MODE

Before writing in this mode, the fast and front meshes should first be erased and prepared. The writing beam can then write into the fast mesh and the recorded waveform is transferred as soon as possible after that to the front mesh. The storage layer of the fast mesh has a low capacitance, which gives a high writing speed but a low storage time. The front mesh is the type used in conventional storage cathode-ray tubes and has the facility of variable persistance operation.

A complete erase/prepare - write - transfer cycle is now described. The voltage waveforms that are applied to the storage electrodes are shown in Fig. 3.3.
In order to erase/prepare, the front mesh is connected to a +500 V, 100 ms pulse (the first erase pulse) and then returned for 500 ms to its original potential of approximately 0 V. This first erase pulse starts immediately after the ERASE pushbutton is released. After the 500 ms zero potential period there is a second erase pulse of about 10 V applied to the front mesh for 900 ms. At the end of this pulse the mesh is applied to a potential that is somewhat lower than the zero potential. This level is adjustable and controls the sensitivity of the fast mesh after its preparation.
During the preparation period of the front mesh, at 300 ms after the start of the second erase pulse, the fast mesh is lowered from 140 V to about +5 V in order to prepare it.
At the end of the second erase pulse of the front mesh the storage section is ready to be written in. The erase/prepare - write - transfer cycle is interrupted here and the storage system waits for the time-base sweep that writes the fast mesh. During the waiting period the charge condition of the fast mesh is stabilised by pulses with an upper level of +140 V. These stabilising pulses have a 150 Hz frequency and a duty cycle of 0.07 %.
Immediately after the time-base sweep has ended and the fast mesh has been written into, a transfer pulse of +500V, 100 ms duration, is applied to the front mesh. During this transfer pulse, the fast mesh potential is slightly lowered.
The charge pattern on the fast mesh has now been transferred to the front mesh.
During the whole erase/prepare - write - transfer cycle of the storage meshes the collimator electrodes 3, 2 and 1, and the flood gun accelerator are pulsed in the positive direction.
Figure 3.3. also shows a time-base blocking signal and the time-base sweep. The time-base is unblocked from 100 ms after the end of the second erase pulse until the start of the time-base sweep; only during this period can it respond to a trigger signal.

3.1.5.5. STORE MODE

In this mode, the storage electrodes of the c.r.t. are applied to constant d.c. voltages. Only the flood gun accelerator is pulsed, using a 100 Hz square wave with an upper level of +20 V and a lower level of 0 V. The duty cycle is adjustable between 0 and 80 % by means of the INTENS control (R14). A duty cycle of 80 % gives a maximum brightness of the recorded waveform and 0 % gives a blanked display.

The remaining storage electrodes are applied to constant d.c. voltages, typically as follows:

- front mesh voltage between −5 V and +15 V,
- fast mesh voltage of +140 V,
- collector mesh voltage of +150 V,
- 3rd collimator voltage of +75 V,
- 2nd collimator voltage of between +30 V and +90 V,
- 1st collimator voltage of 30 V,
- the time-base is continuously blocked.

3.1.5.6. NON-STORE MODE/MEMORY OFF

In this mode the storage system of the c.r.t. is switched off and the storage electrodes are applied to constant d.c. voltages, typical values being as follows:

- front mesh at −35 V,
- fast mesh at +140 V,
- collector mesh at +150 V,
- 3rd collimator at +75 V,
- 2nd collimator at +30 V to +90 V,
- 1st collimator at +30 V,
- flood gun accelerator at +20 V.

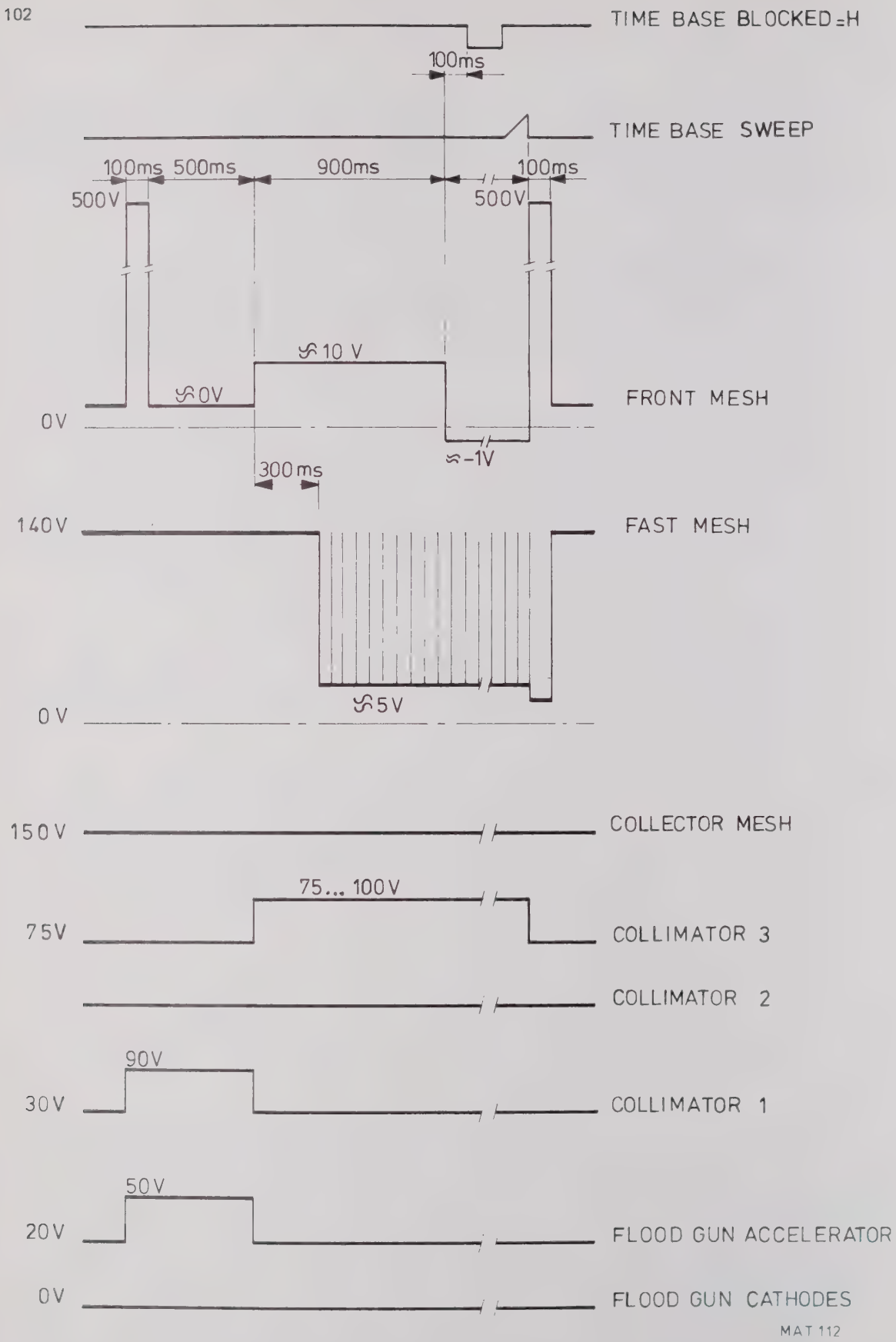


Fig. 3.3. Voltage wave forms applied to the storage electrodes of the CRT in the FAST mode.

3.1.5.7. Storage Section Block Diagram Description

The block diagram of the storage section is shown in Fig. 3.1. The voltage waveforms that are applied to the storage electrodes have already been described in the previous section. The storage electrodes are connected to the outputs of their appropriate amplifiers, i.e. the fast mesh is connected to the FAST MESH AMPLIFIER, and so on.
The FRONT MESH AMPLIFIER and the FRONT MESH PREAMPLIFIER are of special interest. If the output voltage of the FRONT MESH AMPLIFIER is "high", the front mesh is connected to +500 V; if the output voltage is "low", then the front mesh potential is that of the output voltage from the FRONT MESH PRE-AMPLIFIER.
The amplifiers receive their input signals from the STORAGE LOGIC. This block can be subdivided into the following functional sections:

- pushbutton switch detector
- timer
- auto-erase timer
- dual oscillator
- ETB and BTB pulse generator
- stabilisation pulse generator
- input switching for storage amplifiers

PUSHBUTTON SWITCH DECODER

This block is operated by the front-panel storage control pushbuttons: STORE, WRITE, and FAST (S24A, S24B and S24C). Depending on the combination of the pushbuttons selected, one of the four functional outputs FAST, WRITE, STORE and NON-STORE is activated. A faulty pushbutton combination automatically activates the STORE output. The decoder is arranged in such a way that a further selected pushbutton combination does not affect an erase/preparation - write - transfer cycle that is already in progress. Only at the end of the cycle can the new pushbutton combination become effective.

TIMER

In the WRITE and FAST modes this block generates output pulses for the timing of the erase/prepare cycles. If the ERASE pushbutton (S25) is released, or if the AUTO ERASE TIMER generates an output pulse, the TIMER generates pulses on separate outputs after 100 ms, 600 ms, 900 ms, 1200 ms and 1500 ms.

AUTO-ERASE TIMER

In the FAST mode this block generates pulses if the VIEW TIME control (R16) does not occupy the MAX position. These pulses trigger the TIMER in the same manner as after release of the ERASE pushbutton. The pulses have a duration of 1 ms and a repetition rate that is adjustable by means of the VIEW TIME control of between 3 s and 8 s. In other words, after a view time that is adjustable between 3s and 8 s the display is erased and another picture is written if the time-base is triggered.

DUAL OSCILLATOR

The dual oscillator receives a 100 Hz square wave from the 100 Hz MASTER OSCILLATOR. This oscillator is not synchronised by the mains supply voltage. One output from the DUAL OSCILLATOR produces a 100 Hz square wave of which the duty cycle can be adjusted between 0 and 30 % by the PERSISTENCE control (R16). This signal is used to pulse the front mesh in the variable persistence position.
The other output produces a 100 Hz square wave of which the duty cycle can be adjusted between 0 and 80 % by the INTENS control (R14). This signal is used to pulse the flood gun accelerator in the STORE mode in order to adjust the brightness of the recorded waveform.

ETB PULSE AND BTB PULSE GENERATOR

This block generates in the FAST mode pulses at the end of the time-base sweep (ETB pulse) and at the beginning of the time-base sweep (BTB pulse).

At one output a positive-going pulse appears at the beginning of the sweep of the selected time-base, and at the other output a positive-going pulse appears at the end of the sweep of the selected time-base.

STABILISATION PULSE GENERATOR

This block operates in the FAST mode and generates "needle" pulses with a frequency of 150 Hz and a duty cycle of 0.07 %. These pulses are applied to the fast mesh of the c.r.t.

INPUT SWITCHING OF STORAGE AMPLIFIERS

This block produces the output signals that feed the inputs of the storage amplifiers. In turn, these amplifiers drive the storage electrodes of the c.r.t.

The output signals of the INPUT SWITCHING block are derived from the output signals, produced by the DUAL OSCILLATOR, the ETB/BTB PULSE GENERATOR and the STABILISATION PULSE GENERATOR.

The pulse sequence of the output signals is determined by the setting of the storage control pushbuttons (S24A, S24B, S24C)together with the output pulses from the TIMER. These output pulses from the TIMER are initiated on the release of the ERASE pushbutton or by the AUTO-ERASE TIMER.

3.1.5.8. Focus and Z-Amplifier Block Diagram Description

The focusing of the electron beam of the c.r.t. is controlled by the setting of the INTENSity control (R14). This coupling between the Z-amplifier and the focus is such that the spot on the c.r.t. screen remains well focused over almost the entire intensity range.

The c.r.t. has a scan magnifier facility and this necessitates two focussing electrodes; one is active in the vertical direction and the other is active in the horizontal direction.

The intensisty is influenced by the following signals:

- the setting of the INTENS control (R14),
- a signal applied to the external Z-modulation input X8,
- a signal from the chopper oscillator, used for blanking in the CHOPped mode,
- a signal from the X-deflection selector, used for display blanking in the ALTernate mode,
- a signal that increases the intensity in the TB MAGN x10 mode,
- a signal from the storage logic that increases the intensity in the FAST mode,
- a signal from the AUTO, TRIG, SINGLE switch that controls the intensity in the single shot mode.

The above-mentioned input signals are applied to the INTENSITY AND FOCUS PREAMPLIFIER. This amplifier has two outputs that have identical signals, but with a phase difference of 180 degrees.
One output feeds the Z-amplifier. The other output feeds the FOCUS AMPLIFIER via a correction network comprising a zener diode and a resistor. This network compensates for the difference in focus and intensity characteristics of the c.r.t

The output signal from the Z-amplifier must be applied to the Wehnelt cylinder (G1) of the c.r.t. which stands at a potential of about –3 kV. The h.f. components can be directly applied to G1 via a d.c. blocking capacitor. However, the d.c. and l.f. components are first applied to the MODULATOR where they modulate an h.f. carrier. They are then fed via a d.c. blocking capacitor to the DEMODULATOR. The output signal from the DEMODULATOR consists of the d.c. and l.f. components, which are then applied to the Wehnlet cylinder (G1) of the c.r.t.

The output signal from the FOCUS AMPLIFIER is divided into two parts; one for vertical focusing and the other for horizontal focusing.

The vertical focusing is controlled by R19, which adjusts the VERTICAL FOCUS AMPLIFIER that drives the vertical focusing electrode G5 of the c.r.t

The horizontal focusing is controlled by R17 on the front panel, which adjusts the HORIZONTAL FOCUS AMPLIFIER that drives the horizontal focusing electrode G3 of the c.r.t.
The deflection coefficients of the c.r.t. are affected by the cathode potential of the c.r.t. Therefore, the –3 kV cathode voltage is stabilised by a –3 kV STABILISER that has a potentiometer adjustment control.

3.1.6. Stabilized power supply

The mains voltage is full-wave rectified and fed to a regulated sine converter.
The output voltage of the sine converter is kept constant by regulating the duty cycle of the applied voltage. This output voltage is applied to the primary of a transformer, the secundary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The MAINS triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuitry on a safe level.
An additional power supply unit makes the supply voltages for parts of the storage system.

3.2. CIRCUIT DESCRIPTION

3.2.1. Vertical deflection system

The oscilloscope contains three vertical channels, channels A and B and the TRIGger VIEW channel.
The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel switch, controlled by the display mode pushbuttons, switches either channel A or channel B or the TRIGger VIEW channel to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube.
The individual stages of the vertical deflection system are now described in some detail.
As the channel paths for channel A and channel B are basically identical, only the channel A signal path is described.

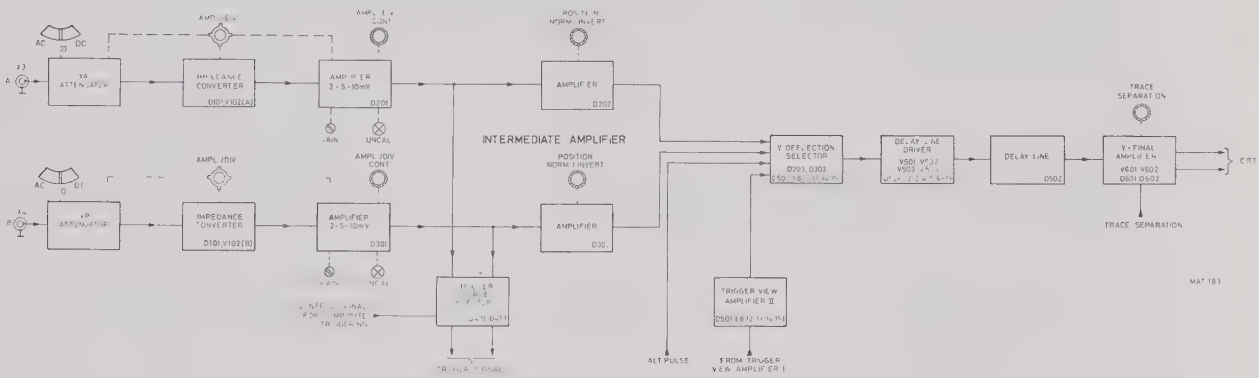


Fig. 3.4. Vertical deflection system

3.2.1.1. Input coupling

Input coupling switch S17 (AC-0-DC) forms a part of the input attenuator unit (Unit 2).
Input signals connected to the A input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected.
In the AC position of S17, there is a capacitor (C102) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier and reduces so the lower frequency limit to 10 Hz.
In position DC of switch S17, the input signal is coupled directly to the step attenuator and at the same time, blocking capacitor C102 is discharged via R101, to prevent damage of the circuit under test by a possible high charge.
Selection of the 0 position of S17 isolates the channel A input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

3.2.1.2. Input attenuator and impedance converter

The input stage comprises two identical attenuator circuits which are combined in one unit (unit 2).
For convenience, only the channel A attenuator is described.

The input attenuator consists of a triple high-ohmic voltage divider and an impedance converter in conjunction with a drift-correction circuit. The impedance converter provides an output at zero level, which can be adjusted by potentiometer R129, followed by a low-ohmic attenuator with attenuation factors of 1, 2 and 5.

The overall attenuation of the input stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the eleven positions of the front panel AMPL/DIV attenuator switch S9.

The high-ohmic voltage divider sections attenuate by a factor of X1, X10 and X100. The low-ohmic divider D102 following the impedance converter, V102, V103, V104 gives attenuations of X1, X2 and X5 at the output. With the overall combinations of attenuation, eleven Y deflection coefficients are realised from 2 mV/DIV to 5 V/DIV in a 1-2-5 sequence. Only for the most sensitive positions 2 mV/DIV and 5 mV/DIV of the AMPL/DIV switch S9, the gain of the intermediate amplifier is increased.

Constant input capacitance for the various attenuator positions is achieved by trimmers C101, C104 and C109. The high-ohmic voltage divider sections are made independent of the input frequency (i.e., the capacitive attenuation for a.c. signals is adjusted to the resistive attenuation for d.c. signals) by means of trimmers C107 and C112.

A diode clipper V101, in the gate circuit of FET-transistor V102 protects the input source follower of the impedance converter from excessive voltage swings.

The high frequency path of the input signal consists of capacitor C114 and FET-transistor V102 connected in a source-follower configuration. The low frequency path of the input signal consists of error amplifier D101, which samples the input and output signals of the impedance converter over a frequency range from d.c. to 1 kHz. The error amplifier generates a correction signal on pin 6 which is fed to the impedance converter to replace the missing low frequency components of the high frequency path.
The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Preset R 132 (L.F. corr) is adjusted so that the ratio of the network R134/R132 is the same as the ratio of network R122/R123. The off-set voltage of the error amplifier is corrected by preset R124.

After low-ohmic attenuator switching, the output from the impedance converter provides a correct impedance match for the coaxial cable to the intermediate amplifier.

3.2.1.3. Intermediate amplifier

The intermediate amplifier comprises two main stages.
The first stage comprises the gain adjustments, vernier and continuous control, level shifting, and sensitivity for the 2 mV, 5 mV and 10 mV ranges.

The second stage comprises a series-shunt feedback amplifier circuit formed by D202 input transistors and transistors V502, V504 on the delay-line driver circuit. Interposed in this stage are the normal/invert, shift and electronic switch facilities.

Both stages have overall gains of approximately 3.

To improve temperature control and stability, the intermediate amplifier mainly comprises integrated circuits. The signal paths for channel A and channel B are identical in the input stages, consequently, only the channel A input circuit is described.

The Y signal from the channel A attenuator is applied to a coaxial input socket on the intermediate amplifier, via R204 to pin 3 of integrated circuit D201. The asymmetrical input is converted to a symmetrical output in a transistor balance amplifier.

Potentiometer R212 provides a continuous balance control to correct for line shift.
Four diode-connected transistors across the base circuits of the D201 cascode transistors provide control of attenuation by means of GAIN control R12 and CONT. control R8, which vary the dynamic resistance of the diodes. Control R12 gives 5 % loss of gain in the mid-position and 10 % loss of gain at minimum. Control R8 gives a 3 to 1 attenuation, which is sufficient to give the desired overlap between the input attenuator steps. When the currents through the diode bridge are equal, there is no gain and the transistors are cut off. When current flows in one diode and not in the other, the gain is maximum.

The cascode transistors V204 and V203 that follow integrated circuit D201 provide additional gain for the most sensitive ranges by the selection of load resistors. By switching this additional gain at intermediate amplifier level a reduction in noise is achieved.
The different loads of V203, V204 are selected by switching diodes under the control of the front-panel AMPL switch positions.
In the 10 mV-5 V positions the - 5.2 V supply from AMPL/DIV switch S9 contact 14 is applied to the junction of R241, stabistor V205 and diode V208. The stabistor V205 conducts and applies the negative potential via switching diode V206 to load resistors R228 and R236 of V204 and V203 respectively. Diode V208 also conducts and blocks V211, thus causing transistor V212 to switch off and disconnect the load resistors R231 and R234.

In the 5 mV position, the - 5.2 V supply from AMPL/DIV switch S9 contact 20 is applied to the junction of R242, and diodes V209, V210. Diode V210 conducts and applies the negative potential via switching diodes V207 to the load resistors R229 in series with R228, and R233 in series with R236 of V204 and V203 respectively. Diode V209 also conducts and blocks V211, thus causing transistor V212 to switch off and disconnect the remaining load resistors. To compensate for the reduction of bandwidth in the 5 mV position because of the higher value of the load resistor, an additional capacitor, C202, is switched into the emitter circuit via R209 and diode V201.

In the 2 mV position, transistor V212 conducts because of the 0 V applied to its base via R246 and V211. The resulting negative potential on its collector is applied to the total load resistors R231, R229, R228 and R234, R233, R236 of V204 and V203 respectively. In this position, switching diodes V206 and V207 are blocked. The 2 mV position is an extra facility, the bandwidth being degraded to 35 MHz.

To compensate for any shift of the trace that may occur when switching between the 5 mV and 10 mV positions, preset R222 is provided. It permits the emitter current of V203 to be adjusted, as required.

Emitter potentials for V203 and V204 are routed via feed resistors R224 and R227 respectively. The RC networks R226, C213 and R230, C212 provide damping. Series RC networks R221, C214 and R214, C206 on points 1 and 8 of the cascode circuit of D201 prevent any tendency for parasitic oscillation.
The second stage of the intermediate amplifier is a voltage-to-current amplifier that incorporates the trigger pick-off point, the NORMAL/INVERT switching facility, and the channel selection switching. The stage basically comprises two integrated circuits D202 and D203.
Emitter points 4 and 5 (D202) of the input transistors provide the trigger pick-off points that are routed to resistors R403 and R414 on the trigger circuit. A number of RC networks across the common emitter circuit provide for bandwidth compensation over the frequency range. Preset components are R253, R254 R255 and C221.

The NORMAL/INVERT function is performed by a diode-gate switching circuit under the control of the PULL TO INVERT switch S4. In the NORMAL position, i.e. S4 is open, transistor V216 conducts because of the negative base potential applied via diode V217 and resistor R263. Point 11 of D202 is therefore at 0 V and this is applied to the bases of two transistors, which conduct and pass the signal through D202 without inversion (points 1-14, 8-12). The negative potential via R262 is passed to point 9 of D202 on the appropriate side of the diode gate network. This negative potential is applied to block the bases of the other pair of transistors in the signal path.

In the INVERT position, i.e. S4 is closed, V216 is cut off because of the 0 V potential applied via V218. Point 11 of D202 now becomes negative via R261 and this switchess off the two transistors that were previously conducting. The signal path is now inverted through the integrated circuit (points 1-13, 8-15) by the 0 V signal applied via S4, R264 to point 9 of D202.

Any trace shift due to inversion can be corrected by preset R259.
The output signals are fed to pins 1 and 8 of integrated circuit block D203, the emitters of the electronic switching transistors. Channel selection is by means of a diode-gate network, controlled from the logic circuit.

Front-panel POSITION control R3 applies a variable potential to the base of one of the input transistors to provide a means of shifting the trace. Transistor V219 provides a constant-current source, unaffected by the shift control.

3.2.1.4. Trigger pick-off and trigger source selection

The symmetrical trigger inputs from the A channel intermediate amplifier (D202) are fed via resistors R403 and R414 to points 3 and 6 of D401.
The symmetrical trigger inputs from the B channel intermediate amplifier (D302) are fed via resistors R453 and R464 to points 3 and 6 of D451.
Diode switches are again employed for channel switching for triggering on channel A, channel B or for composite triggering.
The outputs are asymmetrical and are taken via coaxial sockets to the trigger amplifier of the Main and Delayed time-bases.
The operation of the two integrated circuits D401 and D451 is identical. Therefore, only the channel A circuit D401 is described.

Transistor V401 provides a constant current source for the trigger pick-off stage for channel A. The collector output (point 7) is resistor-coupled to the common emitters of the switching transistors to provide a high gain output on point 13 (MTB trigger output) and point 15 (DTB trigger output) when the appropriate triggering is selected. Switching is achieved by front-panel selection. When channel A (DTB) is selected, the +11,4 V from point 2 of S21-A (which blocks V403 in the channel A OFF position) is removed and V403 conducts the channel A trigger signal (D401/15) to the delayed time-base trigger amplifier. When channel A (MTB) is selected, the +11,4 V from point 1 of S22-A is removed and V404 conducts (V407 off) to pass the channel A trigger signal on D401, point 13) to the main time-base trigger amplifier.

In the composite triggering mode, which is only functional when also ALT mode is selected, point 4 of S22-A is open circuited, consequently, transistors V408 and V458 and also transistors V457 and V407 are now controlled by a signal coming from the vertical logic circuit via R1622 and V462. This signal brings transistors V458 and V408 alternately into conduction to enable triggering on the channel being displayed.
Transistor V459 inverts the logic input signal to allow alternate switching of the two channels.
Diodes V454 and V404 are alternately conducting and the A and B trigger signals are alternately routed to the MTB trigger amplifier.
Presets R426 and R476 enable the switching points of the diodes V404 and V454 to be set.
Presets R472 and R422 compensate for any current differences between the A and B triggering signals to enable the same current to be delivered to the trigger amplifiers.

3.2.1.5. Vertical display mode logic

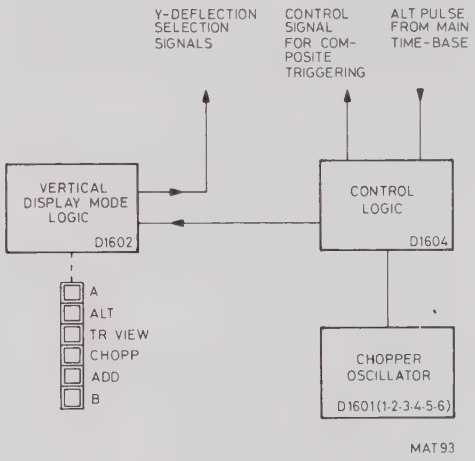


Fig. 3.5. Vertical display mode logic

This logic consists of digital circuits employing dual-in-line TTL integrated circuits. Vertical mode selection is made by selector switch S1.
The outputs that can be selected by the vertical display mode selector switch S1 are:
– channel A only
– channel B only
– TRIG VIEW signal only
– channels A and B added, chopped or alternated
– TRIG VIEW signal and channels A and B, chopped or alternated.

Positive logic is used in the digital circuits, the levels being as follows:
logic "1" = +5 V (high)
logic "0" = 0 V (low)

The different functions of the logic circuits are now described according to the vertical display mode selector switch S1.

A — selects channel A only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to +5 V and the R input (point 8) to 0 V. The "high" level at output 10 is fed via two NOR circuits and R1628 and R1626 to R289 in the A channel preamplifier to open the A channel signal path.
At the same time the control signals for the B and the TRIG VIEW channel are 0 V.

B — selects channel A only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to 0 V and the R input (point 8) to +5 V. The high level at output 11 is fed via two NOR circuits and R1627 and R1624 to R389 in the B channel preamplifier to open the B channel signal path.
At the same time the control signals for the A and the TRIG VIEW channel are 0 V.

ADD — adds channels A and B. Inputs 2 and 5 of NOR circuits D1603 are connected to +5 V via switch S1, consequently both outputs 1 and 4 are low. They are fed via the NOR circuit and the resistors to R289 and R389 in the A and B channel preamplifiers to open both signal paths simultaneously. The TRIG VIEW control signal is 0 V then.

TRIG VIEW — selects the trigger signal only. Via switch S1 a +5 V is applied to points 4 and 5 of NAND D1607 (4-5-6). Output point 6 is fed via NOR D1602 (1-2-3) and resistors R1629 and R1623 to R547 in the trigger view amplifier to open the trigger view signal path.
The channel A and B control signals are 0 V then.

CHOP — selects channels A and B chopped. In this position the chopper generator, which consists of NAND circuits D1601 (4-5-6) and D1601 (1-2-3), is switched into the circuit by a +5 V applied to input 4. The frequency of oscillation is 2 MHz. The output signal is fed via two NANDS to the clock input of flip-flop D1604. The only flip-flop of interest now is the first one. It divides the incoming frequency by two and switches at a frequence of 1MHz. The resulting high switching levels on the outputs 10 and 11 of the flip-flop provide the chopping signals for the A and B channels.
The control signal for the TRIG VIEW channel is blocked in this situation.

During switching over in the CHOP mode, the c.r.t. is blanked by pulses supplied via transistor V1601 to R2002 of the blanking stage.

ALT — selects channels A and B alternately for display. The circuit acts as in the CHOP mode, only the chopper generator is blocked and the circuit is driven now by the much slower switching signal applied to input 2 of NAND D1608 (1-2-3).
This switching signal is derived from the main time-base generator (V903) or the alternate time-base logic. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.
In ALT TB mode the circuit is switched at the end of every two sweeps.
The control signal for the TRIG VIEW channel is 0 V.

ALT TRIG VIEW — selects channels A and B and TRIG VIEW alternately. So three signals can be made visible on the screen, but only one at a time is written.
For the generation of the control signals see Fig. 3.6. Clock pulses are here the alternate pulses.

TRIG VIEW CHOP — selects channels A and B and TRIG VIEW chopped. Three signals can be made visible on the screen, but now in chopped mode.
For the generation of the control signals see Fig. 3.6. Clock pulses are here the chopper generator output pulses.

Composite triggering

The output signal of point 10 of flip-flop D1604 is applied via R1622 to diode V462 in the trigger source selector.

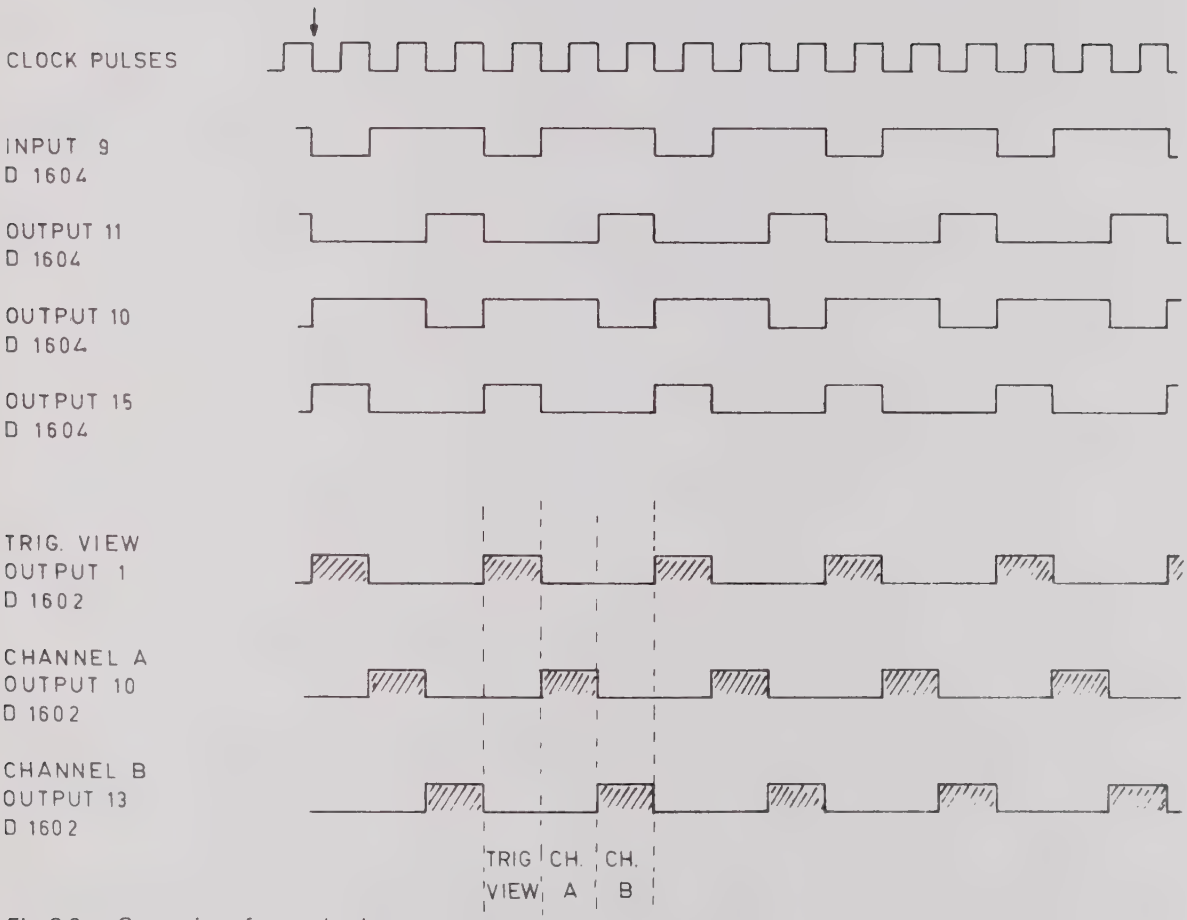


Fig. 3.6. *Generation of control pulses.*

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3.2.1.6. Delay-line driver

The signal collector outputs from D203 (points 12 and 14) are coupled to the bases of the output transistors V502, V504 of the shunt-series feedback amplifier and each normally draws 10 mA from the current source of V501, V503.
When the channel is switched off by the diode-gate network, the signal transistors are blocked and the alternative transistors are switched on so that they now draw 20 mA current from the +11,4 V rail via resistors R502, R501, R508, R507.
Similarly, the collector outputs from D303 of the channel B intermediate amplifier are also coupled to the bases of V502, V504.
In the ADD position, with both the A and B channels switched in, 20 mA is fed to V224 and V322 and, similarly, 20 mA to V222, V324. Since the alternative transistors in D203 and D303 are now switched off, only 10 mA is drawn via the R501 and R507.
The table shows the current distribution in the stage for the various operating modes.

MODE	CURRENT DISTRIBUTION		
A switched	10 mA through V224	20 mA through V509, V323	10 mA through V222
B switched	10 mA through V322	20 mA through V509, V223	10 mA through V324
ADD switched	20 mA through V224, V322	10 mA through V509	20 mA through V222, V324
TRIG VIEW	10 mA through V508	20 mA through V223, V323	10 mA through V511

By the use of alternative transistors in the various switching modes, the current demands of delay-line driver stage are constant irrespective of the switching.

The collector outputs of transistors V502 and V504 are direct-coupled to the bases of the output transistors of the delay-line stage (points 3 and 6 respectively of integrated circuit D501). Resistor R541 in the emitter circuit provides gain compensation for temperature changes in the stage. The collector outputs on points 2 and 7 of D501 feed the combined output resistor R552, the value of which, 120 ohms, matches the characteristic input impedance of the delay line.

A cable-type delay line is used with a characteristic output impedance of 75 ohms. From the delay line, the signals are routed to the vertical output amplifier stage, via input resistors R602 and R609, which terminate the delay line in 75 ohms. Transistors V601 and V602 in common-base configuration provide the first stage of the vertical output amplifier.

3.2.1.7. Final Y amplifier

The voltage signals present on R604 and R613 are applied to the bases of transistors (point 3 and point 6) of integrated circuit D601.
The emitters of these transistors (points 4 and 5) are fed from a constant-current source, V606, via transistors V607 and V603. The base of V607 is controlled via V608 from the TRACE SEP; potentiometer R6 on the time-base circuit.
This potentiometer varies the current on the side of the balanced amplifier to give trace separation in the ALTERNATE TB mode.
The networks R634, C613, R636, C614 and C616 provide delay-line correction at different frequencies.
High frequency compensation for this stage is achieved by V609, C617 and V611, C618 adjusted by preset R646. The NTC resistor temperature-controls the vari-cap capacitance and compensates for increase in temperature.
Integrated circuit D601 and thin-film circuit D602 form a shunt-series feedback circuit, followed by a cascode amplifier with voltage output developed across the load resistors inside D603.
The Y plates of the c.r.t. are fed via series chokes L601 and L602 damped by the parallel resistors R662 and R664.

Together with the capacitance of the c.r.t. plates, this forms a series resonant circuit to lift the gain at the high frequency end of the bandwidth. Preset R654 provides a measure of gain adjustment (20 % approx.) to allow for different c.r.t. sensitivities.
It controls the quiescent current of the diodes and thus the gain of the D601 amplifier stage.
Any unbalance in the c.r.t. deflection plates can be corrected for by the line centring preset R658, which provides a compensating current for one side of the balanced output stage.

3.2.2. Main time-base triggering

The trigger source switches for triggering the main time-base generator, can select any of the following input sources.:
– an internal signal from the vertical A channel
– an internal signal from the vertical B channel
– an internal composite signal of channel A and channel B
– a signal derived from the mains supply
– an external source.

All these sources can be used for both triggering and X Deflection purposes. Source selection is done by means of a trigger selector switch S22.

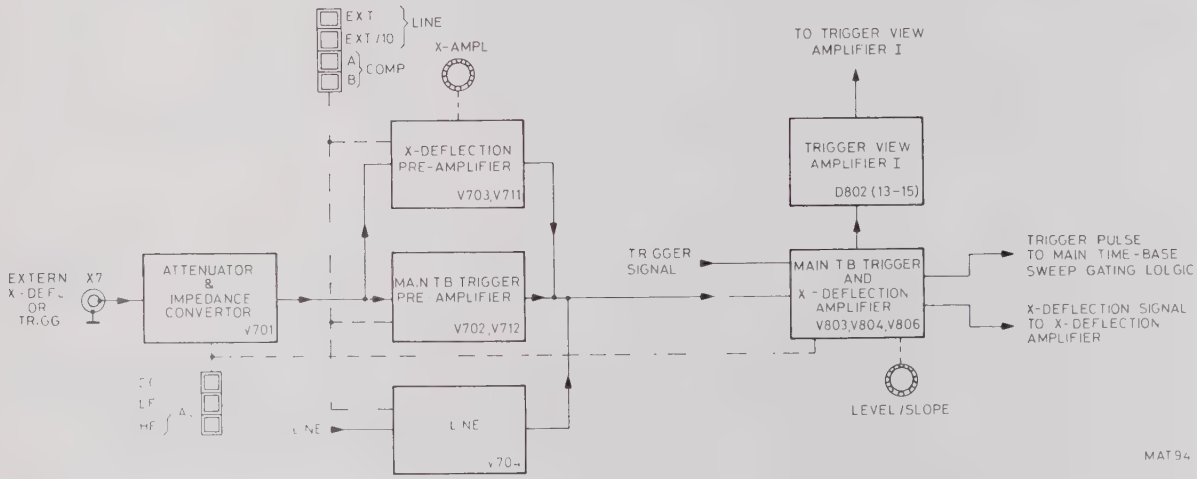


Fig. 3.7. Main time-base trigger circuit

3.2.2.1. Main time-base trigger source selector and preamplifier

The signal which is applied to the external trigger or X-deflection input X7 is attenuated via R702 and R703 by a factor of 10 in the EXT ÷ 10 mode.
When DC coupling is selected with switch S20, a DC path is formed via the resistors R707 and R708 to input 3 of D701. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C704 to point 3 of D701 and the h.f. component is then fed via capacitor C703 to FET V701. The output signal from V701 and D701 is then applied to the bases of the transistors V712 and V711.

In the modes A, B, COMP and LINE the junction of R714 and R718 is connected to ⏚ via switch S2, transistors V702 and V703 are conducting thus blocking the signal paths via the diodes V708 and V709.

In LINE mode R722 is not longer connected to ⏚ and transistor V704 is blocked. Diode V707 will conduct and the signal path for the LINE signal is opened.

When modes EXT or EXT ÷ 10 are selected there is no voltage applied via S22 to the junction of R714 and R718. In these modes there is only one of the transistors V702 and V703 conductive and the other one is then blocked.

If V702 is conductive, the signal path via diode V709 will be blocked. The signal path via diode V708 will be blocked when V703 is conductive.
If V702 or V703 conducts depends on the setting of switch S2.
There is no voltage applied via S2 to R716 and R717 in normal horizontal deflection by MTB and/or DTB signals. Transistor V702 is blocked, V706 and V703 conduct and the signal path via diode V709 is opened.
In EXT-X DEFL mode a +5 V signal is applied to R716 and R717 and V702 is conducting. At the same time V706 and V704 are blocked and the signal path via diode V708 is opened. The X-AMPL potentiometer R18 in the emitter circuit of V711 is now brought into the circuitry.

3.2.2.2. Main time-base trigger amplifier

The main time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier. In this trigger amplifier, there is an output taken off for trigger view.

The signal current from the intermediate amplifier (channel A, channel B, or composite) is fed via the trigger source selector circuit to the emitter of V803. The output from the trigger source (EXT, EXT ÷ 10, or LINE i.e. mains frequency) is also fed to the emitter of V803.
This transistor, connected in common-base configuration, is coupled to the shunt feedback stage V804, V806.
The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example the DC position, selected by switch S20, is switched in by the −11,4 V which causes diodes V808 and V812 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V814, which compensates for the temperature drift of transistor V804.

On the trigger amplifier, the trigger view signal and the trigger signal proper are split up by means of integrated circuit D802.
The two input transistors (points 2, 3, 4 and points 5, 6, 7) accept the trigger signal and the trigger LEVEL voltage respectively. Their outputs combine to feed a differential amplifier.

The LEVEL voltage control R7 permits variation of the trigger level of the signal.
The collector current from the trigger signal and trigger level transistors is fed to the combined emitters of the differential amplifier. The required current division is obtained by varying the voltage on the bases of the two inner transistors of the differential amplifier by means of preset potentiometer R852 applied to point 9.

The collectors connected to points 13 and 15 provide the trigger view output. The collector currents on points 14 and 12 are fed to the shunt feedback stage V819 and V818 respectively, thus providing the trigger signal.

In the negative position of the +/– SLOPE switch S7, the trigger signal is taken from one of the collectors via R824 and diode V823, and in the positive position via V821 and diode V822.

+/– SLOPE switch S7 determines the polarity of the trigger signal. In the closed position a 0 V signal causes V823 to conduct the negative trigger, and also switches off V828. In the open position, V828 is switched on and the positive trigger is routed via V822 and V823 is blocked.
In this way, the appropriate trigger signal is supplied to the time-base.

3.2.3. Main time-base generator

The main time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit and an auto sweep circuit.

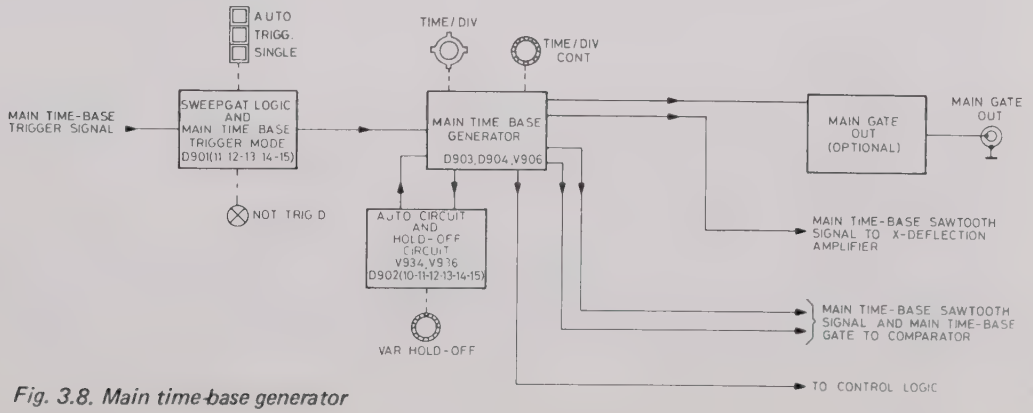


Fig. 3.8. Main time-base generator

The operation of the main time-base generator is based on the principle that a capacitor charges linearly when a constant-current source is applied, and can be periodically discharged rapidly by means of an electronic switch. In this way, a linear saw-tooth waveform is generated.

The constant-current source consists of transistors V913, V914 and integrated circuit D903. The emitter voltage of V914 has the same potential as point 3 of D903, therefore a constant voltage exists across the series circuit of R926 and the charging resistors on switch TIME/DIV S15. This voltage, and thus the charging current may be varied by means of potentiometer R11 and the preset potentiometers R911 and R913, which compensate for the tolerances of the timing capacitors.

In the TRIG. position V931 is switched off because of the +5,2 V applied to its base by switch S8 (AUTO). If point 14 of the master slave flip-flop D901 is logic "high" due to a trigger pulse, V929 will also be switched off.
Consequently, its collector will be negative and switching transistors V906, V907 will be turned off (discharge switch open) and the timing capacitors C916 and C917 in parallel (and C912, C913 or C914 as selected) will be charged. This charging voltage is applied via the buffer stage consisting of the Darlington pair emitter-follower V922, V923 (h.f. path) and via the operational amplifier D904 together with V924 (l.f. path) to point 12 of the R; S; flip-flop D902. This flip-flop reaches its switching voltage when the time-base-saw-tooth voltage rises to approximately +4,3 V. Output 14 will then be "high" and output 15 will be "low". Since the collector of V937 is positive (see operation of AUTO circuit), diodes V927 and V926 will conduct and the "high" output on point 14 of D902 will be applied to point 12 (S input) of flip-flop D901. This results in a "low" output on point 14 of D901 irrespective of the state of the other inputs. The "low" output causes V929 to start conducting and its collector becomes less negative. Consequently, switching transistors V906, V907 conduct (discharge switches closed), the timing capacitance is discharged and point 12 of D902 drops below the switching level. Transistor V944, the base of which was turned on by the "high" output (point 14) of D902, is now switched off.
In turn, transistor V956 (discharge switch for the hold-off circuit) is switched off and allows the hold-off capacitance (C928 and C926, C927 as selected) to be charged by current source V954, D906. The voltage on point 3 of D906 is derived from a resistor that carries the charging current of the time-base generator. Therefore, the charging current for the hold-off capacitance is proportional to that for the time-base capacitance, thus giving a constant relationship between time-base length and the hold-off time. Potentiometer R18 (HOLD-OFF) allows the length of the hold-off period to be increased by a factor of 10. When the voltage across the hold-off capacitance has risen to a value of approximately 4,3 V the flip-flop D902 will be switched to its original state (outputs 14 low, 15 high), via buffer stage V949, V948. The "low" state on the base of V944 causes it to conduct and turn on V956 to discharge the hold-off capacitance. As a result, point 10 of D902 drops below its switching level. The S input of D901 will also be low again, whereupon the clock input (point 11) will be effective. The D input (point 10) is coupled with the clock pulse. Due to this pulse the flip-flop is switched over, resulting in a low level on point 15 and a high level on point 14 to permit the new time-base sweep.

3.2.3.1. Free run AUTO-circuit

If as a result of a trigger pulse, the Q output (point 15 of D901) is low, V934 and V936 start conducting and provide a discharge path for capacitor C923. Resistor R957 has been selected so that the current through R958 is insufficient to bring the base-emitter voltage of V936 to 0,7 V; therefore, both transistors are cut off as soon as C923 has discharged, provided that the Q output has switched to "high" in the meantime. The voltage on the negative side of C923 is then approximately +3,5 V and V937 is turned off, as a result of which diodes V926 and V927 are able to transfer the pulse on D902 output 14 to input 12 of D901.
Transistor V931 is turned off because its base is held at +5,2 V via R959, R960 and R962 (switch S8 (AUTO) is interrupted in the AUTO position). Thus, with a trigger signal input the time-base operates in the same way as in the TRIG position.

However, in the absence of a trigger signal, when D901 output 15 is "high", capacitor C923 will be slowly charged to approximately −6 V. If before this charging time (0.1 s approx.), point 15 turns to "low" (due to a trigger signal), C923 is discharged again before V937 starts conducting. As a result, V937 remains switched off and the instrument is still triggered.

If the voltage across C923 is permitted to charge to −6 V (i.e. no trigger signals appear), V937 starts to conduct and the resulting negative on its collector blocks diodes V926 and V927. At the same time, the base voltage of V931 drops. Consequently, the pulse on output 14 of D902 is no longer transferred to input 12 of D901, but is fed direct to the switching transistors V906, V907 via diode V932 and transistors V931 and V929.

In this way, the time-base generator runs automatically without the intervention of a trigger pulse. Transistor V937 is conductive when the time-base generator is not triggered. The base of V939 is then low, as a result of which the transistor conducts and the NOT TRIG'D lamp (V2) lights.

3.2.3.2. SINGLE SHOT mode

In the trigger position SINGLE, the time-base hold-off capacitors are short-circuited by diode V953 and switch contacts S8 (AUTO) and S8 (TRIGG).
The flip-flop D902 must then be reset manually by the RESET button S8 (SINGLE), which applies +5,2 V via R975, V946 to input 10. After input 10 has been brought to a high level and the RESET button released, triggering can occur, but on one event only as the flip-flop is not reset automatically.
In the SINGLE mode, V937 is permanently turned off via R965 by S8 (AUTO) and S8 (SINGLE). Since diodes V941 and V942 are now conductive, the pulse on output 14 of D902 will be transferred to the base of V939.
Consequently, the NOT TRIG'D lamp will light during the period when output 14 of D902 is low, i.e. from the moment the RESET button is pressed until the end of the time-base sweep initiated by the incoming trigger pulse of the event under observation.

3.2.4. Delayed time-base triggering

The trigger source switches for triggering the delayed time-base generator, can select any of the following input sources.

- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal signal derived from the main time-base to start the delayed time-base immediately after the selected delay time
- an external source

Source selection is done by means of a trigger selector switch S21.

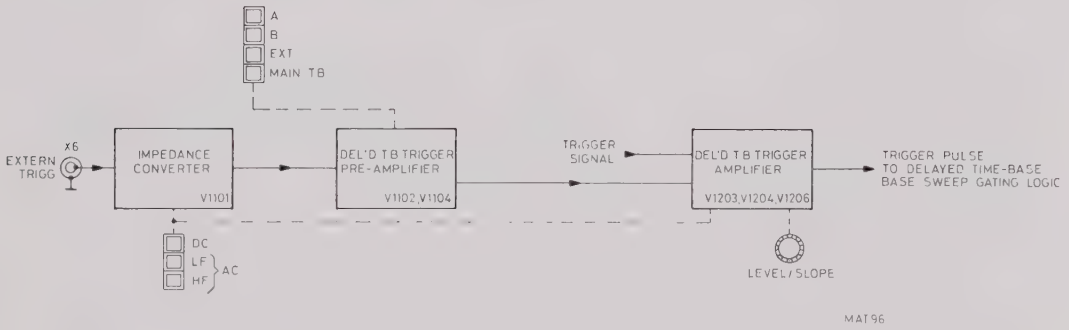


Fig. 3.9. Delayed time-base trigger circuit.

3.2.4.1. Delayed time-base trigger source selector and preamplifier

The signal which is applied to the external trigger input X6 is fed via the input stage consisting of FET transistor V1101 and integrated circuit D1101 to the base of V1104.
When DC coupling is selected with switch S19, a DC path is formed via the resistors R1103 and R1104 to input 3 of D1101. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C1102 to point 3 of D1101 and the h.f. component is then fed via capacitor C1101 to FET transistor V1101. The output signal from V1101 and D1101 is then applied to the base of transistor V1104.

In the modes A, B and MTB the emitter of transistor V1102 is connected to the +11,4 V via switch S21, transistor V1102 is conducting thus blocking the signal path via the diode V1103.
When mode EXT is selected, there is no voltage applied via S21 to the emitter of transistor V1102. This transistor is blocked and the signal path via diode V1103 is opened.

The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Adjusting is done with preset potentiometer R1118 (L.F. corr.).

3.2.4.2. Delayed time-base trigger amplifier

The delayed time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier.

The signal current from the intermediate amplifier (channel A, channel B or composite) is fed via the trigger source selector circuit to the emitter of V1203. The output from the trigger source (EXT) is also fed to the emitter of V1203.
This transistor connected in common-base configuration, is coupled to the shunt feed-back stage V1204, V1206. The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example, the DC position, selected by switch S19, is switched in by the −11,4 V which causes diodes V1208 and V1212 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V1214, which compensates for the temperature drift of transistor V1204.

The two transistors V1216 and V1217 accept the trigger signal and the trigger LEVEL voltage respectively.
The LEVEL voltage control R5 permits variation of the trigger level of the signal.
The collector currents of V1216 and V1217 are fed to the shunt feedback stage V1219 and V1218 respectively, thus providing the trigger signal.

In the negative position of the +/− SLOPE switch S6, the trigger signal is taken from one of the collectors via V1224 and diode V1223, and in the positive position via V1221 and diode V1222.

+/− SLOPE switch S6 determines the polarity of the trigger signal. In the closed position a 0 V signal causes V1223 to conduct the negative trigger, and also switches off V1228. In the open position, V1228 is switched on and the positive trigger is routed via V1222 and V1223 is blocked.
In this way the appropriate trigger signal is supplied to the time-base.

3.2.5. Delayed time-base generator

The delayed time-base generator comprises a sweep gating logic, a sweep generator, a comparator and an end of the sweep detector.

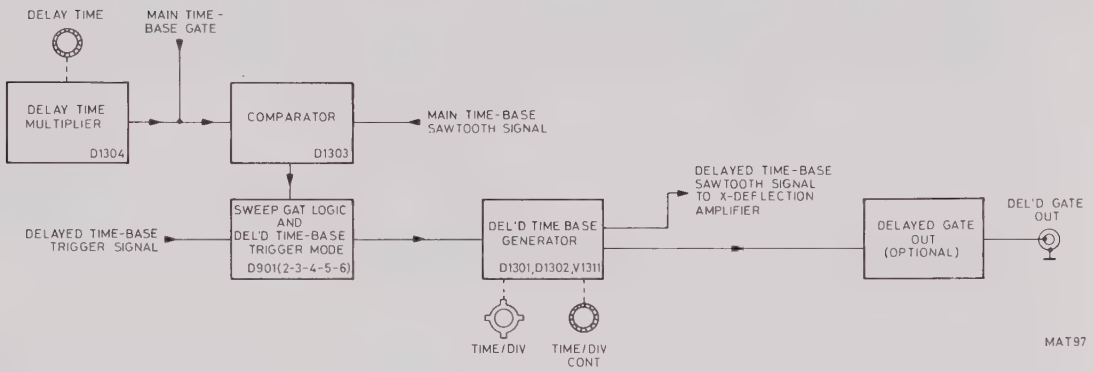


Fig. 3.10. Delayed time-base generator

Before considering these stages in detail, the general principle is briefly described.
Basically, the sweep gating logic, under the control of trigger signals from the trigger circuit and also feedback pulses from the end-of-the-sweep detector circuit, supplies square-wave pulses to the switching transistors V1309 and V1311 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed via the X-deflection selector to the X-final amplifier.

3.2.5.1. Delayed time-base sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors C1311, C1312 are always in circuit, the capacitors C1307, C1308 and C1309 are selected by the transistors V1319, V1322 and V1323 respectively. These transistors operate as electronic switches and are either fully cut-off or fully-conducting. They are switched on by the application of a positive voltage on their bases from the TIME/DIV switch S13. According to the position of S13 the transistors switches in one of the capacitors in parallel with C1311 and C1312.
As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistors V1317 and V1318. This current can be adjusted in steps by selecting the emitter resistance of V1318 by means of the TIME/DIV switch S13.

Continuous control of the charging current can be effected by varying the drive to point 3 of integrated circuit D 1301 with the continuous sweep control, TIME/DIV potentiometer R10.
Potentiometer R1326 enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator.
Together with C1307 and C1309, transistors V1314 and V1312 are switched into the circuit by a +5,2 V voltage from the TIME/DIV switch S13. In these positions potentiometers R1323 and R1322 provides a fine adjustment for the timing circuit.
The discharge circuit for the time-base capacitors consists of transistor V1311, which is driven by the sweep gating logic.
The resulting sawtooth voltage is fed via an l.f. path and an h.f. path to the X-deflection selector. The l.f. path consists of integrated circuit D1302 and transistor V1328 and the h.f. path consists of transistors V1326 and V1327.

3.2.5.2. Delayed time-base end of the sweep detection circuit

This circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output is applied to point 7 of SR flip-flop D902.

At the end of the time-base sweep, output 2 of the SR flip-flop D902 will be "high" and output 3 will be "low". These logic levels are transferred to pins 5 and 4 respectively of D901 irrespective of the state of the comparator D1303. As a result, the $\overline{Q}$ output becomes "low" and the timing capacitors are discharged via V1311, since the flip-flop D902 is not reset until the end of the main time-base sweep (D902-15 on MTB connected via a differential network to D902-5 on DTB). This situation will persist until the next sweep of the main time-base. If the main time-base sweep is completed before the end of the delayed time-base, the R and S inputs (5 and 4) of D901 are switched over and the delayed time-base capacitors also are discharged.
The system can now be triggered again.

3.2.5.3. Delay time function

The function of the DELAY TIME potentiometer R1 is to provide an adjustable d.c. voltage for comparison with the sweep voltage of the main time-base generator. This comparison is then used to start the delayed time-base generator at a pre-determined time during the sweep of the main time-base.
The DELAY-TIME potentiometer R1 is a 10-turn front-panel control.

3.2.5.4. Comparator circuit and sweep gating logic

The comparator consist of an integrated circuit D1303. Transistor (points 6-7-8) is a constant-current source for the transistors (points 1-2-3 and points 3-4-5) of a differential amplifier.
The d.c. voltage set by the DELAY TIME potentiometer R4 is fed to the base of transistor (points 3-4-5). The sawtooth voltage of the main time-base generator is fed to the base of the other transistor. As soon as the amplitude of the sawtooth exceeds the set d.c. voltage, a high level is passed from D1303, pin 5, to input 4 of master-slave flip-flop D901 (R input), and a low level from D1303, pin 1 to S input 5 of D901.
The $\overline{Q}$ output on point 3 will then be high, with as result that V1304 and the time-base capacitor discharge switches V1309 and V1311 will be turned off. This is the situation in the MTB position of the switch S21.
In positions A, B or EXT of delayed time-base trigger selection switch S21, point 4 of D901 is always low via S21 The delayed time-base then starts first upon receipt of trigger pulses on clock input 6, after the S input has dropped to the low level.

3.2.6. X deflection selector and alternate time-base logic

Depending on the selected position of X deflection source selector switch S2, the circuit provides for X deflection by the main time-base signal, the delayed time-base signal, a signal from an external source or X deflection by one of the internal signals derived from channel A, channel B or the mains voltage. There is also the possibility to select, the main and delayed time-base alternately.

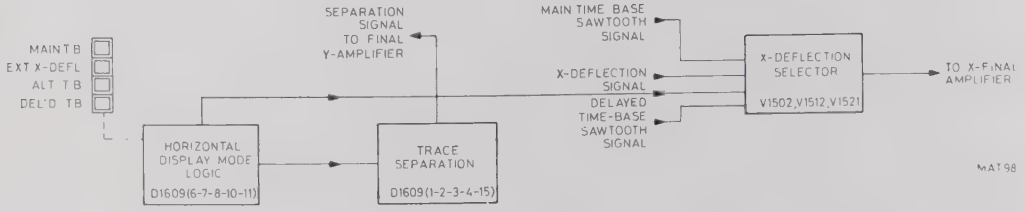


Fig. 3.11. X deflection selector and alternate time-base logic

The different functions of the logic circuits are now described according to the horizontal display mode selector switch S2:

MTB

– When no pushbutton is depressed or when MTB is depressed flip-flop D1609 is set in the MTB position via its R and S inputs (output 10 is high).
The MTB pushbutton releases all the other push-buttons of the horizontal deflection mode selector, its contacts are not used.
In the MTB position of switch S2, transistor V1509, which is driven by output 10 of flip-flop D1609, and consequently transistor V1511, conduct. Diode gate V1513, V1514 is therefore opened and the main time-base output is applied via transistor V1512 to the X amplifier, via these diodes and R1703.
In this mode only the main time-base sawtooth signal is fed to the X final amplifier and not the delayed time-base sawtooth signal and the X-deflection signal.

DTB

– With DTB selected flip-flop D1609 is set to the DTB state via its S and R inputs (output 11 is high).
In the DTB position of switch S2, transistor V1501, driven by output 11 of flip-flop D1609 and consequently transistor V1506 are conducting. The diodes V1503 and V1504 conduct and provide a signal path for the output sawtooth signal of the delayed time-base generator to the X final amplifier.
With DTB selected the main time-base signal and the X deflection signal are blocked.

EXT X DEFL

– In the EXT X DEFL position a +5,2 V is applied via switch S2 to the base of V1516, with a result that the base of V1517 exceeds +5,2 V and this transistor is turned off.
Transistor V1524 then starts to conduct via R1528 and diode V1523 (8,2 V), and the external signal for amplifier V1519, V1521 is routed via the diode gate V1522, V1526 to the X amplifier.

When EXT X DEFL is switched off, transistor V1516 is turned off and transistor V1517 conducts via R1522. The collector of V1517 is therefore at +5,2 V, and as the voltage across diode V1523 is less than 8,2 V, this diode is blocked and transistor V1524 is turned off. In this position the X MAGN reed relay K1701 for the X1, X10, may be switched in. This is not operative when EXT X DEFL is switched on.

ALT TB

– With ALT TB depressed, the oscilloscope is set in the alternate time-base mode and the main and delayed time-bases are selected alternately.
ALT TB is not possible with DTB TIME/DIV switch S13 in the "OFF" position and with push-button TRIG VIEW of switch S1 depressed.
Switching over from MTB to DTB in ALT TB mode is achieved by switching in transistor V1509 and V1501 in turn via flip-flop D1609.
In ALT TB a +5 V signal is fed to input 4 of NAND D1606. With the delayed time-base switched off and with TRIG VIEW not depressed a 0 V signal appears at output 6 of NAND D1606. With this 0 V signal NAND D1608 (11-12-13) is blocked and flip-flop D1609 is set for normal switching by its clockpulse input signal. There is no longer a signal path for the alternate signal from the time-base generator to the vertical display logic other than via flip-flop D1609, NAND 1608 (8-9-10) and NAND D1607 (8-9-10).
The flip-flop output signal is also applied to R632 in the trace separation circuit to control the vertical space between the two time-base displays.

3.2.7. X Final amplifier

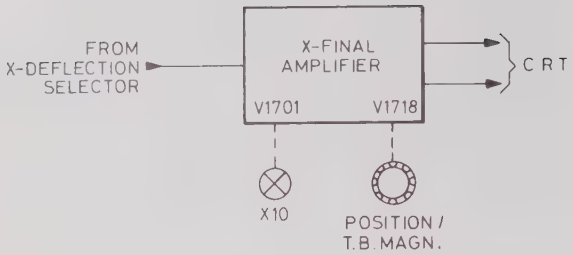


Fig. 3.12. X Final amplifier

The final X amplifier consists of two identical amplifier stages in parallel (one for each deflection plate). One stage consists of transistors V1706, V1707, V1708, V1709, V1722 and V1724 and the other consists of transistors V1714, V1716, V1717, V1718, V1726 and V1723.

The final stage is supplied from the +130 V and −130 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.

The amplifier stages are controlled via the transistors V1701 and V1702.

With the X POSITION potentiometer R2 and V1704 the bias of transistor V1702 can be varied. Potentiometer R2 consists of a tandem potentiometer R2a/R2b with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time-base signals or one of the sources, channel A, channel B, line or an external signal. The X deflection source is selected with the aid of X deflection mode selector switch S2 and the X deflection source selector switch S22.
The selected X deflection signal is applied via R1703 to the base of transistor V1701.

The X amplifier offers the possibility of using either the nominal gain (X1 position of X MAGN switch S3), or the gain increased by a factor of 10 (X10 position of the X MAGN switch S3).
When the front-panel X MAGN switch S3 is operated for X10 magnification, the emitter resistance of V1701 and V1702 is shunted by resistors R1704, R1706 and R1707 via relay K1701, reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.

The X1 gain can be set by potentiometer R1709 and the gain X10 by potentiometer R1706. The gain X10 is not operative when EXT X DEFL is selected.

Both outputs of the X final amplifier are connected to the X deflection plates of the C.R.T.

3.2.8. Storage Section

3.2.8.1. Introduction

See Fig. 3.62. for the circuit diagram.

The first part of this description deals with the functioning of the separate blocks mentioned in the block diagram description and explains the operation of each circuit block under various conditions and modes.

The second part of this description explains how the various pulses are generated that control the c.r.t. storage electrodes in the WRITE, FAST, STORE and NON STORE modes. The pulses generated in these modes are traced through the circuit blocks that are described in the first part to show how the various waveforms on the c.r.t. storage electrodes are derived.

The storage section of the oscilloscope comprises the following circuit blocks:

- Pushbutton switch decoder
- Timer
- Auto-erase timer
- Dual oscillator
- ETB and BTB pulse generator
- Stabilisation pulse generator
- Miscellaneous logic elements
- Quad bilateral switches D2401, D2402, D2403
- Storage amplifiers.

The logic circuits are of the LOCMOS type, which is highly sensitive to static discharges. An explanation is considered necessary for personnel who have had no handling experience with these devices.

HANDLING LOCMOS DEVICES

The word LOCMOS is the abbreviation for Local Oxidation Complementary Metal Oxide Semiconductor, which indicates that field-effect transistors with an insulated gate are used in this type of logic.
Although these field-effect transistors have input protection diodes, this type of logic is sensitive to electrostatic charges.
To safeguard against any possible damage to the LOCMOS circuits, the following rules must be observed:

a. Store and transport the circuits in their original packing, which short-circuits the leads or insulates them from external influences.

b. Electrically connect together to the same potential: testing or handling personnel, measuring equipment, soldering iron and circuit board with the LOCMOS circuits being handled. This potential can, of course, be earth.

c. After the LOCMOS circuits have been mounted on the board, proper handling precautions should still be observed. Until the subassemblies are inserted into a complete system in which the proper voltages are applied, the board is no more than an extension of the leads of the device mounted on the board. To prevent any static discharges from being transmitted through the board wiring to the device, it is recommended that conductive clips or conductive tape be put in the circuit-board terminals.

d. To prevent permanent damage due to transient voltages, do not insert or remove LOCMOS devices, or printed-circuit boards containing LOCMOS devices, from test sockets or systems with power on.

e. Handling personnel should be dressed in clothing of non-electrostatic material (i.e. no wool, silk or synthetic fibres).

3.2.8.2. Functioning of the storage system.

PUSHBUTTON SWITCH DECODER

The pushbutton switch decoder circuit decodes the position of the pushbuttons FAST, WRITE and STORE (S24C, S24B, S24A respectively).
If the WRITE and STORE pushbuttons are depressed together the MEMORY OFF (NON-STORE) function is selected.
If a faulty pushbutton combination is chosen then the STORE mode is automatically selected.

The decoder has eight logic output conditions: FAST, WRITE, STORE and NON-STORE (MEMORY OFF), which are high if the corresponding function is selected, and the four inverse states of these outputs. These logic outputs are available from the quadruple flip-flop D2204.

If the instrument is busy with a particular cycle, e.g. the erase cycle, then a new pushbutton combination cannot interrupt this cycle. This provision is achieved by the fact that the D flip-flop D2204 only loads the new pushbutton combination of it receives a clock pulse on input pin 9. This clock pulse (7 Hz) is derived from an oscillator formed by D2203/8, 9, 10 and D2203/12, 13, 11.
The oscillator is switched on if pin 9 of D2203 is at logic 1. A logic 1 is produced from the $\overline{\text{BUSY}}$ signal (busy not) during a cycle, via diode V2221, and via R2203 and V2219 if the MEMORY OFF function is selected (diodes V2217, V2218 non-conducting by logic 1's on D2202 outputs 12 and 15).

DUAL OSCILLATOR

The dual oscillator formed by operational amplifiers D2222 and D2221 produces two different square-wave output signals, both with a frequency of 100 Hz.
The output signal present on pin 7 of D2221 has a duty cycle that is adjustable between 0 and 30 %. This signal is used as the variable persistence pulse and in the WRITE mode it is applied to the amplifier that drives the front mesh of the c.r.t.

The output signal on pin 8 of D2221 has a duty cycle that is adjustable between 0 and 80 %. This signal is applied in the STORE mode to the amplifier that drives the flood gun accelerator electrode of the c.r.t.

On output pin 6 of D2222 a triangular signal of approximately 100 Hz is available. Because of the RC feedback loop this operational amplifier functions as a 100 Hz master oscillator. This triangular output waveform is applied to the positive input (pin 5) of D2221. Via the PERSISTENCE control R16 and operational amplifier D2221/2, 3, 1 a variable d.c. level is applied to the nagative input (pin 6) of D2221. In this way, the duty cycle at the output (pin 7) of D2221 is adjustable between 0 and 30 % by means of R16.

The 100 Hz triangular waveform from the master oscillator D2222 is also applied to the positive input (pin 10) of D2221. Via the INTENS control R14 and operational amplifier D2221/12, 13, 14 a variable d.c. voltage is applied to the negative input (pin 9) of D2221. In this way, the duty cycle on output pin 8 of D2221 is adjustable between 0 and 80 % by means of R14.
This is operative in the STORE mode.

TIMER

In the WRITE and FAST modes, pulses need to be applied to the various electrodes of the c.r.t. at specific intervals and in the correct sequence after the ERASE pushbutton has been operated. The timer, comprising five delay units connected in cascade, provides delay times of 100 ms, 500 ms, 300 ms, 300 ms and 300 ms. On the outputs of inverters D2212, timing pulses are produced after 100 ms (pin 6), 600 ms (pin 4), 900 ms (pin 2), 1200 ms (pin 10) and 1500 ms (pin 12).

The timer is triggered at the moment that the depressed ERASE pushbutton is released, this moment being referred to as t_o. At the time t_o a positive-going clock pulse reaches the clock input (pin 3) of D flip-flop D2208. This enables the flip-flop to come into the SET condition if the data input (pin 5) is high.
In the WRITE and FAST modes, this data is made high via D2207/1, 2, 3.

In the SET condition of D2208 flip-flop the Q output (pin 1) is high and therefore the input of the first timer section becomes high. This timer consists of R2211, V2206, buffer D2213/14, 15 and C2208.
At the time that the timer input becomes high, input 14 and output 15 of D2213 are low. Capacitor C2208 now charges via R2211; diode V2206 is not conductive.
After a time of 100 ms C2208 is charged sufficiently for input 14 of D2213 to detect a high level and output 15 of the timer also becomes high.

This high output is passed to the input of the next timer section (the 500 ms timer) which consists of R2222, V2207, D2213/11, 12 and C2209 and operates in the same way as the 100 ms timer section. The succeeding timers have identical networks, the difference in delay times being achieved by different values of the resistors that charge the capacitors.
These timing pulses are gated to give the following output waveforms:

Output Gate	**Logic Level**	**Duration after t_o**
D2211/10	high	100 ms
D2211/11	high	600 ms
D2214/11	high in WRITE mode	
	low in FAST mode	900 ms
D2211/4	high	1200 ms
D2211/3	low in WRITE mode	
	high in FAST mode	1500 ms

The output on D2217/pin 2 is the inverse of the signal on D2211/pin 3.

After receiving a high level on its clear input (pin 4) the flip-flop D2208 comes into the reset condition and its Q output (pin 1) becomes low. This results in the input of the 100 ms timer becoming low and C2208 rapidly discharges via V2206 to make output 15 of D2213 low. In turn, the 500 ms timer receives this low input and C2209 is discharged via V2207 and the output of this timer becomes low. This reset action is passed to the succeeding timers in a similar manner.

The D flip-flop D2208 receives a clear command under the following conditions:

a. If the oscilloscope is switched on, the circuit comprising R2314, C2231, V2251 and inverter D2217/7, 6 generates a positive pulse for 550 ms. This pulse is necessary to give certain flip-flops in the storage section a defined preset value after switching on the instrument. D flip-flop D2208 received the 550 ms clear pulse on pin 4 via diode V2252.

b. In the WRITE mode, a clear pulse comes 1200 ms after flip-flop D2208 has been set. This pulse comes via D2207/8, 9, 10, D2207/12, 13,11 and V2205.

c. In the FAST mode, a clear pulse comes 100 ms after the sweep of the selected time-base has ended. This pulse is received via D2207/5,6,4, D2207/12,13,11 and V2205.

NOT BUSY SIGNAL

If the "not busy" line ($\overline{\text{BUSY}}$) is low, it prevents parts of the storage logic from responding to a change in the combination of the mode pushbuttons S24A, S24B, S24C. This line remains low if an erase/prepare - write - transfer cycle is occurring. The "not busy" signal comes from the inverting output (pin 2) of D flip-flop D2208 via diode V2224.

In the WRITE mode: for 1200 ms after t_0 the cathode of D2224 is low and thus the "not busy" line is also low.

In the FAST mode: from t_0 until 100 ms after the end of the time-base sweep the "not busy" line is also low.

ETB AND BTB PULSE GENERATOR

The End of Time-Base (ETB) and Beginning of Time-Base (BTB) pulse generator consists of D2223, a low-voltage to high-voltage translator, followed by NAND gates D2214/5,6,4 and D2214/1,2,3 AND gate D2209/12,13,11, and inverter D2212/14,15.

The generator produces in the FAST mode an output pulse on D2212 pin 15 at the end of the selected time-base, and an output pulse on D2209 pin 11 at the beginning of the selected time-base. The generator is only operative in the FAST mode because pin 15 is made high in this mode.

If the main time-base is selected for horizontal deflection, then input pin 5 of D2223 is high, and input pin 11 is low during the MTB sweep.

If the delayed time-base is selected for horizontal deflection, then input pin 5 of D2223 is low, and input pin 12 is low during the DTB sweep.

D2223 forms an interface between the time-base logic and the storage logic.
The output pulses from D2223 are selected by the logic gates and shaped by the differentiators C2227, R2267 (ETB pulse) and C2232, R2243 (BTB pulse).
At the end of the time-base sweep, a positive pulse with a fast risetime is present across R2267; the negative-going pulse at the start of the time-base is not used.

At the beginning of the time-base sweep, a positive pulse with a fast risetime is present across R2243; the negative-going pulse at the end of the time-base sweep is not used.

AUTO-ERASE TIMER

The auto-erase timer comprises the monostable multivibrator D2227, transistor V2216 and timing capacitor C2217.
In the FAST mode, this circuit generates pulses with an adjustable interval (3 ... 8 s). These pulses have the same result as the operation of the ERASE pushbutton. The repetition time of the pulses is adjustable with the VIEW TIME potentiometer R16. This potentiometer produces a voltage that charges timing capacitor C2217, which is connected to the trigger input (pin 8) of the monostable multivibrator D2227.

The multivibrator is able to trigger if pin 6 is made low; i.e. in the FAST mode. If the voltage on the timing capacitor has reached a certain value, D2227 is triggered and produces a positive pulse at output pin 10 for 1 ms. Transistor V2213 now becomes conductive for 1 ms and gives an erase pulse to pin 3 of D flip-flop D2208. Transistor V2216 also becomes conductive and discharges timing capacitor C2217.

In the MAX position of R16, switch S6 is closed and therefore transistor V2237 is conductive. Transistor V2216 is also conductive and short-circuits C2217 so that the timer is switched off. Erasure can now only take place if the ERASE button is operated.

STABILISATION PULSE GENERATOR

The generator itself consists of the transistors V2243 and V2244, which function together as an unijunction transistor. If the Q output (pin 1) of D flip-flop D2216 becomes high, timing capacitor C2228 can charge via R2246 and R2251. The charging of C2228 continues until a certain voltage is reached and V2243 and V2244 fire (become conductive). A discharge path is thus provided for C2228 and a low pulse is available at the base of V2243 and the collector of V2244. The oscillator produces pulses with a frequency of about 150 Hz and a duty cycle of about 0,07 %.

The D flip-flop D2216 switches the oscillator on the FAST mode 900 ms after releasing the ERASE button when a positive clockpulse is present on pin 3. The flip-flop switches the oscillator off when a clear pulse reaches pin 4 at the start of the time-base. When the instrument is switched on, a clear pulse of 550 ms is applied to pin 4 via D2253. This pulse is generated by the circuit comprising inverter D2217/7,6 and timing elements R2314 and C2231.
Pin 8 of AND gate D2209 is low in the FAST mode from 900 ms after the release of the ERASE button up to the beginning of the time-base sweep.
Pin 9 of AND D2209 gate is low in the FAST mode from 1500ms after the release of the ERASE button until the end of the time-base sweep.
As a result, pin 10 of D2209 is low from 900 ms after the ERASE button is released until the end of the time-base sweep. The stabilisation pulses are available on pin 11 of D2231 from 900 ms after t_o until the start of the time-base. During the time-base sweep pin 11 is high.

TIME-BASE AND Z-AMPLIFIER CONTROL

The Z-amplifier is controlled by the storage logic via emitter-follower V2232, R2278 and V2267.
The time-base is controlled via V2232 and R2287.
This circuit is driven on the base of V2232 by a 100 ms timer comprising R2276, V2266, D2213/3,2 and C2244.
The direction of diode V2266 is such that this timer fuctions differently from the other timers: when the input becomes high, the output is high almost immediately. When the input becomes low, the output becomes low only after a delay time of 100 ms.
The input signal for this times comes from the discrete NAND gate comprising R2274 and the diodes V2261, V2262 and V2263. The following situations are possible.
WRITE mode: The cathodes of V2262 and V2263 are constantly high. Pin 8 of D2214 is also high. Pin 9 of this NAND gate is low for 1200 ms after the moment that the ERASE button is released. Therefore, output pin 10 is high during the same time. Thus, because of the 100 ms delay time, output pin 2 of D2213 is high for 1300 ms after the release of the ERASE pushbutton.

FAST mode: The cathode of V2261 and V2262 are constantly high. Pin 5 of D2203 is also high. Pin 6 of this NAND gate is high from 1500 ms after t_o until the end of the time-base. Because of the 100 ms delay, output pin 2 of D2213 is low from 1600 ms after t_o until the end of the time-base sweep.

STORE mode: The cathodes of V2261, V2262 and V2263 are constantly high and thus output pin 2 of D2213 is constantly high. In this mode, the electron beam in the c.r.t. is blanked by the storage logic.

NON-STORE mode (MEMORY OFF): The cathodes of V2261 and V2263 are constantly high. The cathode of V2262 is constantly low and thus the output pin 2 of D2213 is constantly low. In this mode, the electron beam in the c.r.t. is not blanked by the storage logic.

MISCELLANEOUS CIRCUIT ELEMENTS

In the FAST mode, the data input (pin9) of flip-flop D2229 is high.
At the end of the time-base sweep a positive clock pulse reaches pin 11 and the flip-flop reverts to the set condition: output Q (pin 13) becomes high. The 100 ms delay unit comprising R2302, V2228, D2228/9, 10, D2228/14,15 and C2238 is then activated. After 100 ms, a positive output pulse from the timer reaches the clear input (pin 10) of the flip-flop and resets it.
The 100 ms timer functions in the same way as the 100 ms, 500 ms and 300 ms timers that are already described.
In the FAST mode, the data input (pin 5) of D flip-flop D2229 is high.
The clock pulse reaches pin 3, 600 ms after the release of the ERASE pushbutton and the flip-flop comes in the set condition. Now the output Q (pin 1) becomes high. The 600 ms pulse is derived via inverter D2226/9,10

from the output of the 600 ms timer (D2211/pin 11). At the end of the time-base sweep the clear input (pin 4) becomes high and the flip-flop comes into the reset condition: output Q (pin 1) becomes low.

QUADRUPLE BILATERAL SWITCHES D2401, D2402 and D2403

Each integrated circuit contains four analogue switches (transmission gates).
Each switch has two input/output pins and an "active when high" control input. A high level on this control results in a low impedance bidirectional path between the two matching input/output pins.
A low level on the control input results in a high impedance path between the two matching input/output pins.
The following inputs/outputs and control pins are associated:

- Pin 13 controls the transmission gate between pins 1 and 2.
- Pin 5 controls the transmission gate between pins 3 and 4.
- Pin 6 controls the transmission gate between pins 8 and 9.
- Pin 12 controls the transmission gate between pins 10 and 11.

The transmission gates are used for applying the appropriate signal at the right moment to the inputs of the amplifiers that drive the storage electrodes of the c.r.t.
The control inputs of D2401, D2402 and D2403 are driven by the storage logic.
When such a control input is activated (high) the signal at the input of the gate is switched through the input of the relevant amplifier. This input signal can be adjusted in order to regulate the amplifier output voltage.

FAST MESH AMPLIFIER

The fast mesh amplifier comprises transistors V2402, V2403 operating as a differential input amplifier. The collector of V2403 is direct-coupled to V2408, which drives the complementary output transistors V2404 and V2407. Feedback is provided by resistor R2454.

When no input signals are present, the input to V2402 is provided by a +5.6 V line and the output potential to the fast mesh G11 on R2449 is constant at +140 V.

The amplifier output is controlled by the preparatory pulses and by the image transfer signal. When preparatory pulses are received the output is switched between +140 V and a value that is adjustable between 0 V and +15 V.
During the image transfer, the output voltage becomes a little lower; it is adjustable between −1 V and +15 V.

FRONT MESH AMPLIFIER

The front mesh amplifier consists of input transistors V2458, V2431 and the alternative output transistor pairs V2426, V2427 and V2421, V2422 (each pair is series-connected for high-voltage switching).

When input transistor V2458 is conducting (see WRITE and FAST mode descriptions), the V2431 also conducts. The collector potential of V2431 falls and switches off V2426, V2427. Diodes V2423, V2424 are blocked and output transistors V2421, V2422 now conduct to connect the front mesh G12 to +500 V.

When input transistor V2458 is non-conducting, V2431 is also switched off. The increase in its collector voltage results in output transistors V2426, V2427 conducting and V2421, V2422 are switched off. The front mesh is now connected via output transistor pair V2426, V2427 to the voltage on the output of the front mesh preamplifier. This preamplifier comprises transistors V2414, V2416, V2418 and the output complementary pair, V2412, V2413.

FLOOD GUN ACCELERATOR AMPLIFIER

The flood gun amplifier consists of a differential pair V2437, V2438, the collector output of V2438 being direct-coupled to the base of driver V2442.
In turn, the collector of this transistor is direct-coupled to the base of output transistor V2439. Feedback is provided by resistor R2512.

In the various modes, the output from R2504 to the flood gun accelerator, FGA, can be switched to one of three levels depending on the inputs, as follows:

a. With no input signal the base of V2437 assumes a slight positive potential determined by the feedback resistor R2512.
   In this condition, the output to the FGA is +20 V.

b. When the input to V2437 is earthed by the bilateral input switch D2401 (pin 4 to pin 3) then V2437 conducts further and tends to switch off V2438 and, in turn, V2442. The collector of V2242 goes positive and this increase in potential applied to the base of output transistor V2439 causes it to conduct heavily.

In this condition (see WRITE and FAST mode description), the output to the FGA is at + 50 V.

c. When the input to V2437 is switched to +11.2 V by D2401 (pin 9 to pin 8) then this transistor is blocked. As a result, V2438 conducts and brings V2442 into conduction. The resulting drop in the collector voltage of V2242 is applied to the base of V2439 and switches off this transistor.
In this condition (see STORE mode description), the output to the FGA falls to 0 V.

COLLIMATOR 1 AMPLIFIER

This amplifier, V2444, V2446, is a two-transistor feedback circuit.
With no signal input the output on R2517 to collimator 1 (C1) is at +30 V.

When an earth is applied via D2401 (pin 11 to pin 10) to input transistor V2444, it conducts less and the increase in its collector potential is applied to the base of V2446. As a result, this transistor conducts further. In this condition (see WRITE and FAST mode description), collimator 1 potential is increased to +90 V.

COLLIMATOR 3 AMPLIFIER

This circuit is almost identical to the collimator 1 circuit described.
The amplifier comprises transistors V2449 and V2451. The collimator 3 potential can be switched by an earth from D2401 (pin 1 to pin 2) from its normal + 75V level to between + 75V and + 100V (set by preset R2404) (see WRITE and FAST modes).

COLLIMATOR 2 AMPLIFIER

This is a two-stage transistor amplifier, V2462, V2448, with a preset gain control R2523 in the base circuit of V2448.
The collimator 2 potential can be adjusted between the values of +30 V and +90 V. When there is no input via diode V2464 then the base of V2462 stands at a positive value determined by the +5.6 V line (FAST and STORE modes).

In the WRITE mode, pulses are received via V2419 and diode V2456 which are integrated by C2427.
Depending on the setting of the PERSISTENCE control, the integrated potential on the base of V2462 is modified, and , in turn modifies the output potential to the collimator 2 electrode.

3.2.8.3. Pulse Generation and Control for Storage Modes

This section describes how the storage pulses are generated in the different positions of the pushbutton controls, STORE, WRITE, FAST, and their effects on the various circuit blocks described in the previous section. For a fuller explanation of the functions of any of these circuit blocks, the reader is referred to this section 3.2.8.2. Functions of Storage Circuit Blocks.

Before describing the various modes, a truth table is given in Fig. 3.13., which shows the generation of the decoding pulses for each of the modes.

PUSHBUTTON SWITCH DECODER

TRUTH TABLE

MODE	D2202-2	D2202-15	D2202-12	D2202-4	D2202-6	D2202-10	D2204 I/P 12 13 5 4	D2204 OUTPUT MODE PULSES WRITE 15	FAST 10	STORE 7	NON-STORE 2	NAND GATE D2207-1 SETS TIMER FF D2208
FAST	1	0	0	0	1	1	1 0 0 0	0	1	0	0	1
WRITE	0	1	0	1	0	1	0 1 0 0	1	0	0	0	1
STORE	0	0	1	1	1	1	0 0 1 0	0	0	1	0	0
MEM OFF	0	1	1	1	1	0	0 0 0 1	0	0	0	1	0

Fig. 3.13. Pushbutton switch Decoder.

WRITE MODE

See Fig. 3.14. for voltage waveforms.

When the WRITE pushbutton (S24B) is depressed, a logic 0 is applied to input 14 of inverter D2202 (and to input 4 of AND gate D2201) of the pushbutton switch decoder to give a logic 1 on D2202-15 output pin. This is applied to input 13 of AND gate D2201. Together with the logic ones on the other inputs, 11 and 12 (FAST and STORE pushbuttons normal), a logic 1 is produced on D2201-10. This logic 1 is applied directly to input 13 of quadruple flip-flop D2204 and to inverter D2202/7,6 to give a logic 0 on input 5 of flip-flop D2204.

With the FAST and STORE pushbuttons not selected the input conditions of AND gates D2201/3,4,5,6 and D2201/1,2,8,9 are such that the outputs are at logic 0 and logic zeros are applied to inputs 12 and 4 of flip-flop D2204.

The resulting logic 1 on input 13 of D2204 gives a logic 1 on output pin D2204-15, the WRITE output.

This decoded pushbutton switch output is used to control the WRITE mode functions of the storage logic circuits. It allows the required pulses to be applied to the various electrodes of the c.r.t. after operation of the ERASE pushbutton, S25.

In the WRITE mode, D2204-14 is at logic 0, which gives a logic 1 on AND gate D2207-3. This output provides the set input on D2208-5 for the flip-flop.
Therefore, when the ERASE pushbutton S25 is released the input, via R2202, to the clock, pin 3, produces a logic 1 on the Q output (pin 1) to trigger the timer circuit. As stated, the release time of the ERASE pushbutton is referred to as t_o.

The first section of the timer gives an output pulse on D2211-10 that lasts for 100 ms after t_o. This is routed via diode V2226 and R2486 to the emitter of transistor V2458 at the input of the front mesh amplifier. The 100 ms positive-going pulse is passed to the base of V2431, which conducts, shuts off series transistors V2426 V2427 and brings series transistors V2421, V2422 into conduction. In this way, the first erase pulse of 500 V, 100 ms is passed to the front mesh electrode. This erase pulse and the subsequent pulses that are generated in the WRITE mode are shown in Fig. 3.14.

After this first erase pulse; i.e. at the time t_o + 100 ms, the front mesh potential drops to approximately 0 V, the voltage that is present on the output of the front mesh preamplifier; i.e. on R2474. This output condition is a result of the signal derived from the second section of the timer, which gives a positive output from D2211-11 for 600 ms. This is routed via inverter D2226/9,10, AND gate D2224/3,4,5,6, diode V2234 and inverter D2228/5,4 to the transmission gate input D2403-12. The output on D2403-11 is a 600 ms negative-going pulse that is adjusted by preset R2577 at the input of the front mesh preamplifier to give approximately 0 V on the front mesh after the first erase pulse; i.e. after V2431 is blocked at t_o + 100 ms.
This 0 V signal on the output of the front mesh preamplifier is routed via series transistors V2426, V2427 to the front mesh.

In the MAX WRITE position, R2414 is used to adjust the front mesh potential to a value slightly higher than 0 V, to give the background illumination of the c.r.t. the optimum intensity.
When the PERSISTENCE control is not in the MAX position, the R2414 preset is switched out of circuit by transmission gate D2403/1,2,13. This is activated by a positive input to D2226/3,2, routed via D2231/5,6,4 and D2231/8,9,10.

The fourth section of the timer generates a positive-going pulse on AND gate output D2211-4, which is applied to AND gate input D2224-5. Between 600 ms and 1200 ms after t_o this activates transmission gate D2402/2,1,13 via D2224-6.
The high level input on D2402-13 connects the +11.2 V on D2402-2 to D2402-1. The front mesh can be adjusted by trimmer R2427 to approximately +10 V, the second erase pulse.

After the end of this second erase pulse; i.e. at t_o +1200 ms, dynamic erase pulses are applied to the front mesh. These pulses are derived from the dual oscillator. The frequency of these dynamic erase pulses is 100 Hz and the duty cycle lies between 0 and 30 % dependent upon the setting of the PERSISTENCE control R16. Operational amplifier D2221/2,3,1 together with its RC feedback network R2294, C2239 provides a variable d.c. level to the negative input of D2221-6 to produce this variable duty cycle. The positive input D2221-5 is provided by the 100 Hz triangular waveform from the feedback oscillator D2222/2,3,6. These dynamic erase pulses at output D2221-7 are applied to the input of AND gate D2224-8. As the WRITE input is logic 1 and the input on D2224-2 is also at logic 1 after the 1200 ms pulse, then these dynamic erase pulses are passed via D2224-9 and R2471 to transistor V2419 at the input of the front mesh preamplifier. Trimmer R2423 in the collector of V2419 is provided to adjust the amplitude of the erase pulses to approximately +8 V.
These dynamic erase pulses continue until the time that the ERASE pushbutton is again released (t_o). From t_o until 1200 ms, these pulses are held off by the 1200 ms pulse, which holds input D2224-2 at logic 0.

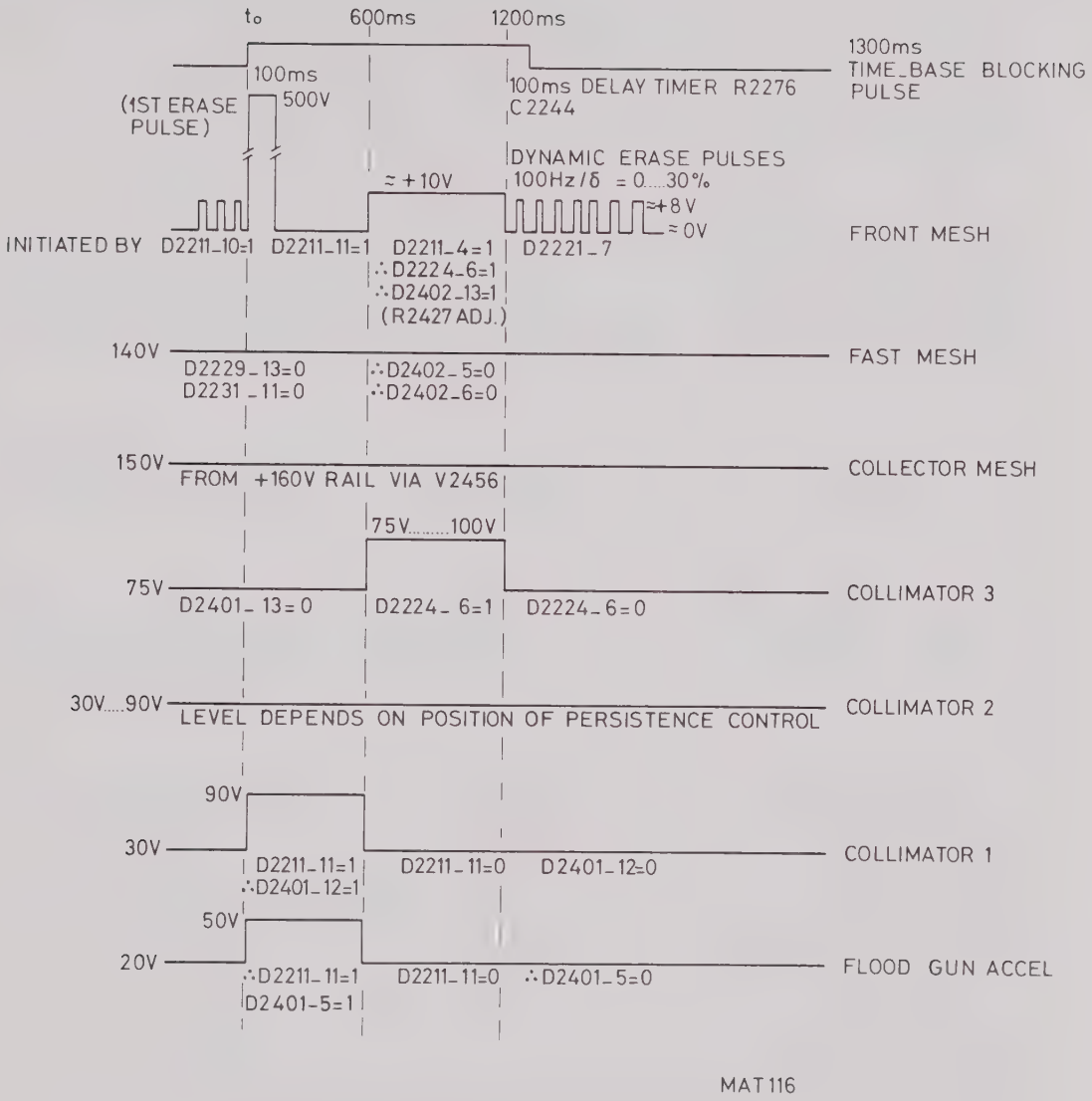


Fig. 3.14. Write mode — Voltage waveforms to storage electrodes.

Fast Mesh

In the WRITE mode the fast mesh is held permanently at +140 V during the erase/preparation - write - transfer cycle as there are no input control signals on D2402 pins 5 and 6. The input of the fast mesh amplifier is held at approximately +5.4 V via presets R2408 and R2412.

Collector Mesh

The collector mesh G10 remains at +150 V (in all modes), this potential being derived from the +160 V supply rail via diode V2457.

Collimator 3

The 3rd collimator is held at +75 V for the first 600 ms as control input D2401-13 is at logic 0. It is then switched to a value between +75 V and +100 V for the next 600 ms by a logic 1 on the output of AND gate D2224-6 (logic ones on all inputs). This logic 1 is routed via diode V2234 to control input D2401-13. After the end of the 1200 ms pulse the output of AND gate D2224-6 reverts to logic 0 and collimator 3 output drops to +75 V.

Collimator 1

At t_0, the positive pulse on control input D2401-12 applies the 0 V on D2404-11 to pin 10, and via R2403, to the base of V2444. As a result, the collimator 1 electrode potential is increased from +30 V to +90 V for the duration of the 600 ms pulse.

Flood Gun Accelerator

At the time t_0, the flood gun accelerator, normally at +20 V is increased to +50 V for 600 ms by a pulse from the second timer section D2211-11. This pulse is routed to control input D2401-5 to switch a +11.2 V input on pin 9 to pin 8 and, via R2402 to input transistor V2437 of the flood gun accelerator amplifier.

Collimator 2

The 2nd collimator is held at a potential of between +30 V and 90 V normally by preset R2523. However, the pulses from the PERSISTENCE control cause V2419 to conduct and diode V2464 conducts as its cathode is pulsed to the 0 V rail.
Depending on the position of the PERSISTENCE control, pulses with a duty cycle of between 0 and 30 % are routed via diode V2464 to modify the potential on integrating capacitor C2427 at the input of the collimator 2 amplifier.
This varies the potential on the collimator 2 electrode of the c.r.t. in proportion to the persistence time of the trace.

FAST MODE

See Fig. 3.15. for voltage waveforms.

When the FAST pushbutton (S24C) is depressed, a logic 0 is applied to input 3 of inverter D2202 (and to input 12 of AND gate D2201) of the pushbutton switch decoder, to give a logic 1 on output D2202-2. This is applied to AND gate input D2201-5. Together with the logic ones on the other two inputs, pins 3 and 5 (WRITE and STORE pushbuttons normal), a logic 1 is applied directly to D flip-flop input D2204-12 and to inverter D2202/5,4 to give a logic 0 on input D2204-5.

With the WRITE and STORE pushbuttons not selected, the input conditions of AND gates D2201/13,12,11,10 and D2201/2,1,8,9 are such that their outputs are at logic 0. Logic zeros are therefore applied to inputs 13 and 4 of flip-flop D2204.

The resulting logic 1 on input D2204-12 gives a logic 1 on output D2204-10, the FAST output.

This decoded pushbutton output is used to control the FAST mode functions of the storage logic circuits that provide the various pulses for the c.r.t electrodes after operation of the ERASE pushbutton S25.

In the FAST mode, D2204-11 output is at logic 0, which gives a logic 1 on output 3 of AND gate D2207. This provides the set input for flip-flop D2208. Therefore, on the release of the ERASE pushbutton S25 the positive clock input, via R2202 to pin 3 of D2208 gives a logic 1 on the Q output, pin 1.
This triggers the timer as in the case of the WRITE mode.

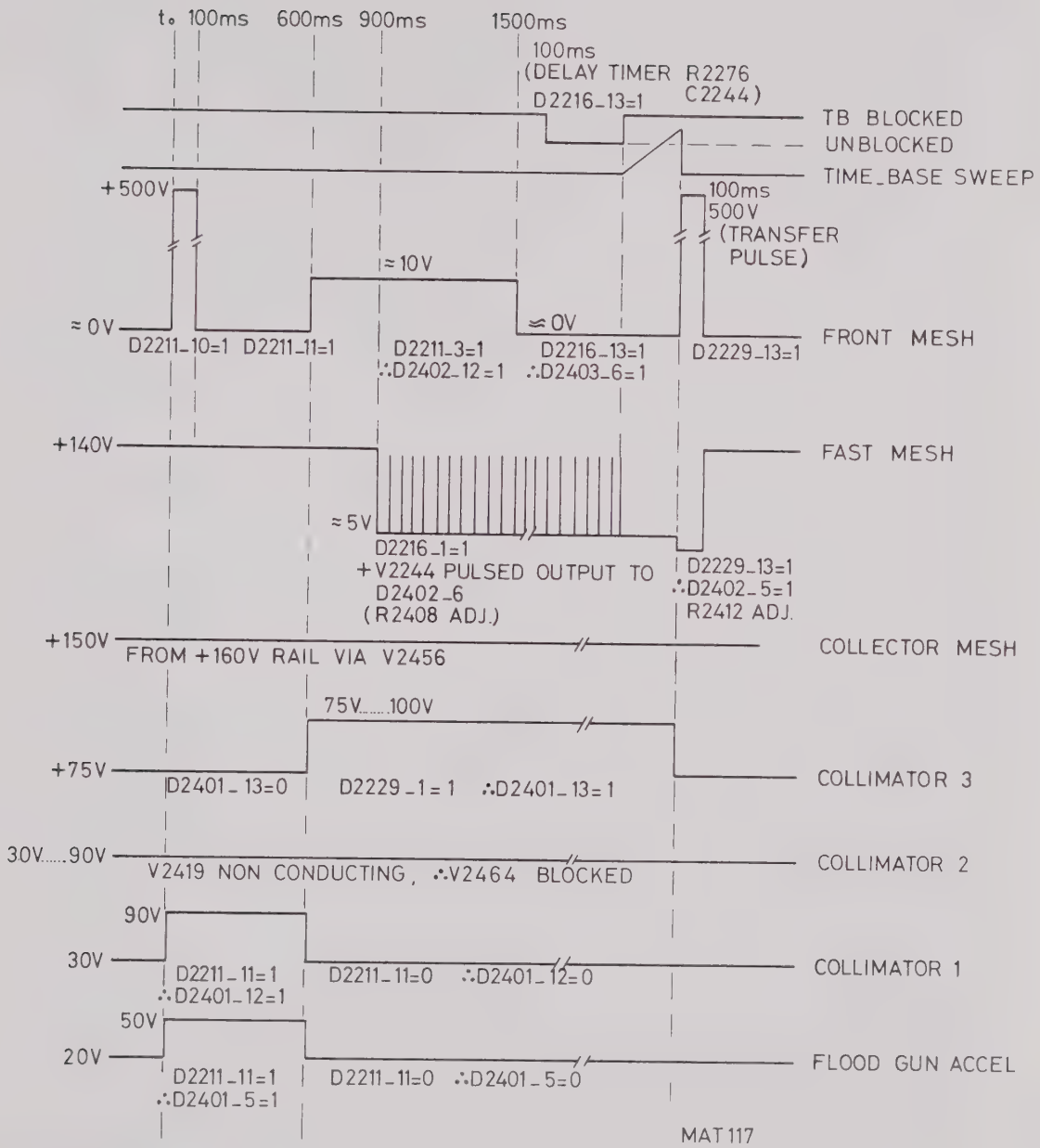


Fig. 3.15. Fast Mode - Voltage Waveforms to Storage Electrodes

The first section of the timer provides the 100 ms pulse on D2211-10 immediately after the release of the ERASE pushbutton. This pulse is routed via diode V2226 and R2486 to the emitter of transistor V2458 at the input of the front mesh amplifier. As described in the WRITE mode, this positive-going 100 ms pulse is fed to the base of V2431, which conducts and cuts off series transistors V2426, V2427. Transistors V2421, V2422 conduct the 500 V first erase pulse and apply it to the front mesh.
At the end of the 100 ms pulse the potential of the front mesh reverts for 500 ms to approximately 0 V, the potential at the output of the front mesh preamplifier.

Also at the time t_o, the 600 ms pulse on output D2211-11 is routed to inputs 5 and 12 of the quadruple bilateral switches D2401. These switches control the inputs to the flood gun accelerator amplifier and the collimator 1 amplifier.
The positive-going pulse on control input D2401-5 switches the 0 V on pin 4 to pin 3. The resulting drop in potential at the base of V2437 causes the output transistor V2439 to conduct further, and the flood gun accelerator potential on R2504 is raised from +20 V to +50 V for the duration of the 600 ms pulse.
At t_o, the positive pulse on control input D2401-12 applies the 0 V on pin 11 via pin 10 and R2403 to the base of V2444, the input of the collimator 1 amplifier. Transistor switches off and the increase in its collector potential causes a further conduction of output transistor V2446. The collimator 1 potential increases from +30 V to +90 V as a result, for the duration of the 600 ms pulse.

At the end of the 600 ms pulse, collimator 3 is raised from 75 V to a value between +75 V and +100 V, adjustable by R2404, by a logic 1 on the Q output of flip-flop D2229 (FAST input on D and a clock pulse from D2226-10 after 600 ms). This logic 1 is routed via diode V2233 to control input D2401-13.
This applies the 0 V on pin 1 to the input of the collimator 3 amplifier, V2449, V2451.

The second erase pulse is generated after t_o +600 ms and holds the front mesh at approximately +10 V for 900 ms. It is provided by the 1500 ms timing pulse derived from AND gate output D2211-3, which feeds a logic 1 to AND gate input D2224-13. Input 12 is also at logic 1 in the FAST mode and input 11 is at logic 1 at the end of the 600 ms pulse, therefore output D2224-10 is at logic 1.
This signal is fed to the control input of D2402-12, which connects the +11.2 V input on pin 10 to pin 11. The resulting +10 V second erase voltage is set by preset control R2429.

At the end of the second erase pulse the front mesh potential is lowered slightly to approximately 0 V until the transfer pulse at the end of the time-base sweep. This potential is initiated by the positive-going SET FRONT MESH input pulse to D2403-6, derived from the Q output of the D2216 flip-flop at t_o + 1500 ms. This input logic 1 on D2403-6 switches the +11.2 V on pin 9 to pin 8, thereby increasing the input potential of the front mesh preamplifier slightly, thus reducing the output potential from +10 V to 0 V. Preset R2419 on the preamplifier input permits adjustment of this voltage.

Fast Mesh

During the preparation of the front mesh, the fast mesh potential is lowered from +140 V to +5 V at 300 ms after the start of the second erase pulse, i.e. at t_o +900 ms. This is achieved by a positive pulse from flip-flop D2216 on output pin 1. The clock input of this flip-flop is derived from the $\overline{900}$ ms output of D2214-11.

The Q output from D2216 is routed via R2246 to an oscillator formed by timing capacitor C2228 and the complementary transistors V2243, V2244 (the stabilisation pulse generator). This provides 150 Hz pulses with a duty cycle of 0.07 % at input 12 of AND gate D2231.
Input 13 of D2231 is also at logic 1 for the period of t_o + 900 ms until the end of the time-base sweep. This pulse is derived from the $\overline{Q}$ output of flip-flop D2216-2 which together with the Q output of D2216-12 is fed via AND gate D2209-10 and inverter D2228/3,2 to input D2231-13 as a logic 1. The pulses on output D2231-11 are routed via diode V2230 to control input 6 of transmission gate D2402. By this means, pulses are switched at 150 Hz from input 9 (+11.2 V) via output 8 to the base of V2402 at the input of the fast mesh amplifier. The low level of the input pulses is adjusted by preset R2408. Transistor V2402 conducts on the negative-going pulses, which results in negative-going pulses at the collector of V2403. These are inverted by V2408 and applied to the bases of the complementary output transistors V2404, V2407. The output on the junction of the emitters consists of the fast mesh preparatory pulses at a frequency of 150 Hz, positive-going from about +5 V to +140 V (duty cycle 0.07 %). The pulses are present until the begin of the time-base sweep.

Time-base

The time-base is unblocked at a time of 100 ms following the end of the second erase pulse; i.e. at t_o + 1600 ms. This is achieved by the Q output of D2216-13 applied to input 6 of NAND gate D2203 at 1500 ms. Together with the FAST input on pin 5, this gives a logic 0 on D2203-4, which via V2263 lowers the input of the 100 ms

timer (R2276, V2266, D2213-3,2 and C2244). The timer output gives a low voltage after a delay of 100 ms; i.e. at 1600 ms. This pulse is fed via emitter-follower V2232 and resistor R2287 to unblock the time-base. The output from V2232 and diode V2267 controls the Z-amplifier.

After the time-base sweep, 500 V, 100 ms transfer pulse is fed to the front mesh. This image transfer pulse is derived from the Q output of flip-flop D2229-13. The clock input on pin 11 is fed from a differentiated pulse produced from the low-to-high voltage translator D2223 (see ETB, BTB pulse generator). The Q output of D2229-13 produces a 100 ms pulse because of the delay circuit R2302, V2228, D2228, C2238 coupled back to the clear input, D2229-10. This pulse is fed from D2228-15 to input 6 of NAND gates D2207. Together with the FAST pulse on D2207-5, a negative-going pulse is produced that is fed to the clear input of flip-flop D2208-4.
As a result, the first section of the timer gives a 100 ms pulse from D2211-10, via V2226, to R2486 on the input of the front mesh amplifier. As described for the first erase pulse, a 500 V, 100 ms transfer pulse is applied to the front mesh.

At the same time as this transfer pulse, the Q output pulse from D2229-13 is also fed to the control input 5 of D2402, which switches a +11.2 V on input 3, via output 4 and preset R2412 to limit the conduction of V2402.
This slightly reduces the +5 V level on the fast mesh during the transfer pulse.

STORE MODE

See Fig. 3.16. for voltage waveforms.

When the STORE pushbutton (S24A) is depressed a logic 0 is applied to the input of inverter D2202-11 (and to the input of AND gate D2201-11) of the pushbutton switch decoder to give a logic 1 on output D2202-12. This is applied to the input of AND gate D2201-8.

With the FAST and WRITE pushbuttons not selected, the input conditions of AND gates D2201/3,4,5,6, and D2201/11,12,13,10 are such that their outputs are at logic 0. Logic zeros are therefore applied to inputs 12 and 13 of flip-flop D2204. Input 4 of D2204 is also at logic 0 because input 1 of AND gate D2201 is at logic 0. However, since outputs 4, 6 and 10 of inverters D2202 are at logic 1, then diodes V2201, V2202 and V2203 are non-conducting and the combined input on pin 5 of flip-flop D2204 is at logic 1. This decoded input to D2204 gives a STORE signal (logic 1) on output pin 7, which is used to control the storage logic circuits in the STORE mode.

In this mode, the flood gun accelerator anode is pulsed by a 100 Hz square wave derived from the dual oscillator formed by amplifier D2222. This produces a triangle input to amplifier D2221-10. The negative input on D2221-9 is supplied with a variable d.c. input from the INTENS control (R14) via operation amplifier D2221/12,13,14. In this way, a square wave output is produced on D2221-8, the duty cycle of which can be varied by the INTENS control between 0 and 80 %. This waveform is inverted by D2217/9,10 and applied to the input of AND gate D2209-5. Together with the STORE pulse on input 6, this produces an output on pin 4 to the control input of transmission gate D2401-6.
In this way, the +11.2 V input on pin 9 is pulsed via pin 8 and R2402, to the input of the flood gun amplifier. The base of V2437, normally at a small positive potential (at 20 V output) is driven more positive by the +11.2 V input pulses and V2437 is blocked during these pulses. Transistor V2438 conducts further as a result and drives the base of V2242 positive. This transistor conducts further and the resulting negative-going collector cuts off output transistor V2439.
As a result, its emitter drops to 0 V during the +11.2 V pulses from D2401-9. The output on the flood gun accelerator via R2504 consists of +20 V pulses with a duty cycle of 0–80% depending on the setting of the INTENS control.

During the STORE mode, the front mesh has a voltage that lies between –5 V and +15 V. This level is controlled by a logic 0 that is present on the output of AND gate D2224-6 (WRITE input 0). This logic 0 output, via V2234, produces a logic 1 on the output of inverter D2228/5,4, which is routed to the control input D2403-12. This connects a + 11.2 V supply from pin 10, via preset R2577, to the input of the front mesh preamplifier to give the store level between – 5V and + 15 V on the front mesh, G12.

Fast Mesh

The fast mesh is held at +140 V in the STORE mode. Output transistor V2404 of the fast mesh amplifier is held conducting because the base of the input transistor V2402 is held at approximately +5.4 V by the feedback via R2454.

No preparatory or transfer pulses are received in this mode to turn off V2402, therefore the output to the fast mesh remains at +140 V.

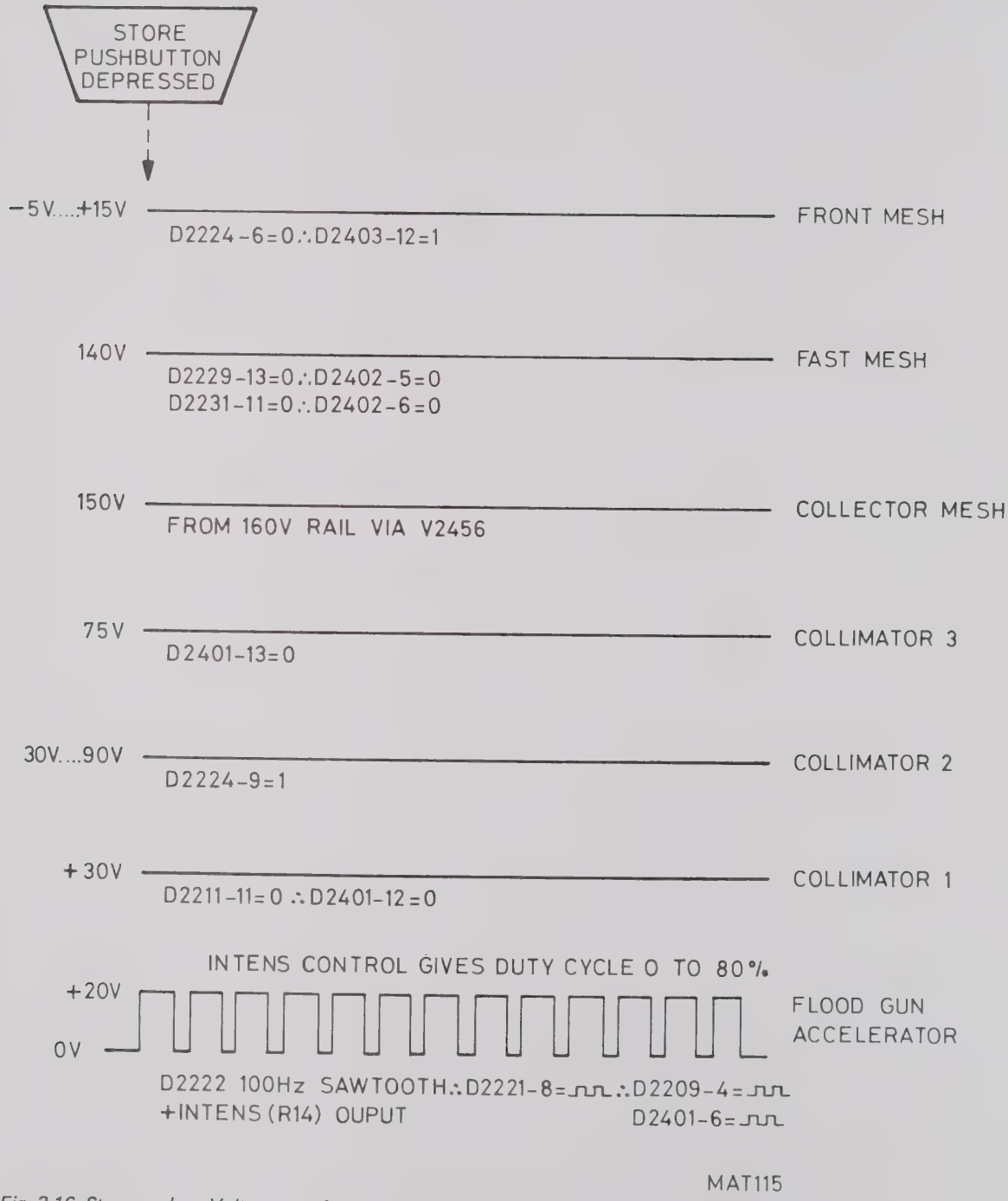


Fig. 3.16. Store mode — Voltage waveforms to storage electrodes.

Collector Mesh

The collector mesh G10 remains at +150 V in all modes, and this potential is derived from the +160 V supply rail via diode V2457.

3rd Collimator

The 3rd collimator is held at +75 V as control input D2401-13 is at logic 0. The earth potential is not switched to output D2401-2 and so the base of V2449 is held positive by the +5.6 V input via preset R2404. Transistor V2449 is therefore more conductive and limits the emitter output of V2451 to +75 V.

Collimator 2

The 2nd collimator is held at a potential between +30 V and +90 V.
In this mode, output 9 of AND gate D2224 is at logic 0 and therefore V2419 is non-conducting. The input of the collimator 2 amplifier is therefore at logic 1. Transistor V2462 conducts and the output of transistor V2448 is adjustable between +30 V and +90 V by preset R2523 in its base circuit.

Collimator 1

The 1st collimator is held at +30 V by means of the positive potential applied to the base of input transistor V2444 via feedback resistor R2518.

MEMORY OFF MODE

When both the WRITE and STORE pushbuttons (S24B, S24A) are depressed together, the MEM OFF or NON-STORE mode is selected.
Logic 0 is applied to input D2202-14 and D2202-11 (and to D2201 inputs 4, 3 and 11) to give logic ones on outputs D2202-15 and D2202-12. Input 1 and 8 of AND gate D2201 are therefore at logic 1, and also the input 2 is at logic 1 (FAST input at logic 1). Consequently, there is a logic 1 on output D2201-9, which feeds a logic 1 to flip-flop input D2204-4. This results in a logic 1 on the NON-STORE output D2204-2.

In this mode, all other inputs to the quadruple flip-flop D2204 are at logic 0, therefore the FAST, WRITE and STORE outputs are also at logic 0.

The logic 1 from D2204-2 is applied to control input D2403-5 to switch the +11.2 V on pin 3 to pin 4 and via R2418 to the base of V2414 at the input of the front mesh preamplifier. This transistor switches off and V2416 conducts, which in turn switches on V2418. The drop in its collector potential makes V2412 less conductive. The negative potential on R2474 is routed via series transistors V2427, V2426 and R2484 to give −35 V on the front mesh, G12.

The potentials to the fast mesh, the collector mesh and the collimators are the same as those for the STORE mode, and the flood gun accelerator is permanently at +20 V (i.e. no input connected from D2401).

3.2.9. Z-AMPLIFIER AND FOCUS AMPLIFIER

The current that determines the intensity of the spot on the c.r.t. screen is applied to the emitter of V2001 and is derived from several sources as follows:

- R2006: the current from this resistor is influenced by the setting of the INTENS control (R14) via V2002. In addition, it is influenced via V2003 by a signal applied to the EXT Z MODulation input X8.
- R2000: the signal applied to this resistor is derived from the storage logic.
- R2002: the signal applied to this resistor is derived from the chopper oscillator (chopper blanking).
- R2001: the signal applied to this resistor is derived from the time-base unit for display blanking if the time-base does not run (time-base unblanking).

The circuitry in the input circuit of the Z-amplifier is arranged in such a way that - depending on the selected display function - the maximum Z-pulse is limited.
The Z-pulse is limited to such a value that maximum intensity will normally not damage the CRT.
However, to be completely safe the intensity control must be operated with care !

WARNING: IN ORDER TO PREVENT DAMAGE TO THE C.R.T. THE INTENSITY MUST NOT BE TOO HIGH.

The circuit that limits the Z-pulse amplitude is located on a small additional unit above the time-base unit.
The Z-pulse is controlled in the following way:

- The maximum Z-pulse in the X EXT mode is limited to 35 Volt because V1517 on the time-base (unit 8) is switched off.
  Now the transistor on the additional unit is switched off and R2009 on the Z-amplifier (Unit 11) does not receive any current.

  In the MTB positions 1 s/DIV ... 5 ms/DIV the transistor on the additional unit is switched off. Via a contact of the MTB switch the junction of R927 and R928 is applied to +5.2 V and a diode on the additional unit becomes conductive so that the transistor switches off.
- If the instrument is not used in the two situations described above the max. Z-pulse is 75 Volt in the SINGLE and FAST modes.

  In the SINGLE mode an earth potential coming from S8b (TRIG) and S8a (AUTO) is applied to the junction of R965 and R983 on the time base unit. Therefore, the transistor on the additional unit can become conductive and supplies current to R2009 on the Z-amplifier.

  In the FAST mode an earth potential is applied to the junction of R965 and R983 via diode V958.

The current applied to the emitter of V2001 is used to determine the intensity and the focusing of the c.r.t. electron beam. As the focusing is influenced by the INTENS setting, the c.r.t. screen will show a well-focused spot over nearly the whole of the intensity range.

The signal from V2001 is applied to a differential amplifier comprising V2007 and V2008. The signals on the collectors of these transistors have a phase difference of 180 degrees.
The signal present on the collector of V2008 is used to drive the focus amplifier consisting of V2031, V2032, V2028, V2023 and emitter-follower V2026. The focus amplifier receives its input signal via a correction network with zener diode V2005 and resistor R2024. This network gives a non-linear relationship between the INTENS control pulses and the focusing control pulses which results in optimum focusing over the whole INTENSity range.

The output signal of the Z-amplifier is present on the emitter of V2013; this signal comprises h.f., l.f., and d.c. components. The h.f. component is applied to the Wehnelt cylinder G1 of the c.r.t. via d.c. blocking capacitor C2077. Grid G1 is at a potential of about −3 kV.

The l.f. and d.c. components are applied to a modulator circuit V2038, V2037 and V2033. The trimming potentiometer R2064 permits intensity adjustment in order to compensate for c.r.t. tolerances.
The modulated signal is connected to the −3 kV level at G1 via d.c. blocking capacitor C2076.
Demodulation is achieved by V2076, V2077 and matching capacitors. The demodulated l.f. and d.c. components are added to the h.f. component on the Wehnelt cylinder G1.
The c.r.t. has two focusing electrodes:

- G3 is used for horizontal focusing and the voltage is adjustable by R17.
- G5 is used for vertical focusing and the voltage is adjustable by R19.

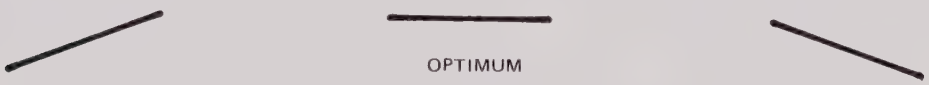
Control R17 is the FOCUS control on the instrument front panel; R19 is a trimming potentiometer located internally that is only adjusted initially. The output signal from the focus amplifier is present at the emitter of V2026. The h.f. component in this signal is applied via C2083 and C2084 to G3 and G5 respectively. In addition, this output signal is equally divided between R2073 and R2134 in order to control the focusing electrodes G3 and G5. The voltage on G3 is controlled by the circuit comprising V2040 and V2039.
Two transistors operating in series are used here to counteract the high voltage. The emitter current applied to V2039 is determined by the output signal from the focus amplifier (via R2073) and by the current from the potentiometer R17. The voltage on G5 is controlled by the circuit comprising V2041 and V2042. Two transistors in series are also used here because of the high working voltage.
The emitter current applied to V2041 is determined by the output signal from the focus amplifier (via R2134) and by the current from the triming potentiometer R19.

CRT CATHODE VOLTAGE REGULATION

In order to prevent variations in the c.r.t. deflection sensitivities, the –3 kV cathode voltage is stabilised. Alternating current variations are applied via C2089 to an amplifier consisting of V2057, V2056 and V2073. Direct current variations are applied to this amplifier via R2086 and R2087. The collector voltage of V2073 compensates for the voltage variations of power supply and rectifier. Consequently, the cathode voltage remains independent of the cathode current.

CRT CONTROLS

TRACE ROTATION is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of potentiometer R15 (screw-driver operated, attainable via a ventilation hole in the left side panel of the instrument). The slider of R15 is connected to the bases of the complementary transistors V2063 and V2064. The trace rotation coil is supplied by these transistors.



With the GEOMETRY control R2103, the battel and pin-cushion distortion is corrected by influencing the voltage on the grid G8.

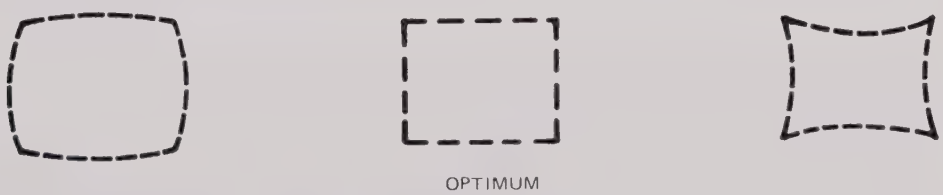


Fig. 3.17. CRT controls trace rotation and geometry.

3.2.10. Power supply

Input circuit

The power supply input circuit is matched to the 115 V or 230 V range with selector-switch S1801 which is located at the power supply unit at the rear side.
The mains voltage is rectified with the diode bridge V1801 and C1802, C1803, which form a voltage doubler in the 115 V position of S1801, and a standard bridge rectifier circuit in the 230 V position of S1801.
The voltage across the series circuit of C1802 and C1803 amounts 250 to 400 V for both mains voltage ranges.

Switching circuit

The unregulated d.c. voltage is applied in the form of pulses to a resonance circuit consisting of the primary coil of the convertor transformer T1801, combined with C1807 and C1808, via switching transistor V1806.
The sine-wave voltage (approx. 800V p.p.) across the primary coil of T1801 is kept constant by regulating the duty cycle of the base current of V1806.
The primary coil of L1806 which is in series with the switching transistor, limits the current through this transistor.
The energy stored in L1806 is fed-back to the mains rectifier circuit, during the cut-off time of V1806, via diode V1811.
V1808 and V1809 keep the dissipation during the switching moments out of transistor V1806; instead of these losses are dissipated in R1814 and R1816.
V1807 improves the base drive for V1806.

Regulator circuit

The regulator circuit itself consists of integrated circuit D1801 (type TDA 1060), the output of which (p.15) supplies a square-wave current with variable duty-cycle to the base of V1812.
The duty-cycle of this signal is variable.
The collector signal of V1812 is applied to the switching transistor via transformer L1803.
The regulator circuit is controlled by:

- Feed-back voltage (p.3)
  This is the regulator control voltage and is taken from the rectifier circuit at the feed-back winding of T1801.
  This control voltage depends on the setting of R1826 (V out).
- Feed-forward (p.16)
  This voltage is derived from the mains voltage and provides direct mains voltage variation compensation.
- Over-voltage protection (p.13)
  This voltage is also derived from the mains voltage and inhibits the regulator output at too high mains voltages (the trip-level on p.13 is 600 mV).
- Current limit (p.11)
  The voltage drop across the current-sense resistor R1811 controls the regulator circuit in case of overload.
- Frequency (p.7)
  The resistance between p.7 and gnd estimates the convertor frequency.
  R1827 (Freq.) has been adjusted to obtain a frequency of 20 kHz.
  The resonance frequency of C1807, 1808 and the primary coil of T1801 is wide enough to tolerate this.

Under normal working conditions the power supply voltages for the regulator circuit are delivered by the rectifier connected to the feed-back winding of T1801.
V1804 is then conducting so that V1803 does not deliver current.

Switching-on

When switching-on the instrument, no supply voltages are available in the regulator circuit, from T1801.
At this moment V1804 is not conducting, so that V1803 is fully conducting, and the regulator circuit gets current via R1804 and R1806.
As soon as the converter circuit is working V1804 becomes conducting and V1803 is not conducting anymore.

Switching-on protection

If the instrument is switched-on and no convertor voltage would appear (due to a possible defect) the PTC resistor R1806 will warm up, reducing the current through V1803 to a safe low value.

Output circuits

The output rectifiers are of the coil-input types delivering the mean value of the sine-wave transformer voltages across the output capacitor. Except the d.c. voltages the convertor transformer delivers also:

- 6,3 V
- 1 kV - 1,5 kV for the focus and high tension circuits
- 120 V for the additional power supply unit.

Photo-coupler circuit

This circuit delivers a sine-wave voltage (derived from the mains voltage) used for mains triggering or mains deflection.
The photo-coupler V1842 which provides isolation between the mains voltage and the oscilloscope's circuitry drives the V1843-circuit in saturation, so that the square-wave voltage at the collector of V1843 has the same value for all mains voltages.
With an integration network R1851, 1852, 1853 and C1836, 1837,1838 the original sine-wave is obtained.
Via V1844 and V1846 this signal is applied to the trigger source selection

Calibration circuit

The calibration unit is a square-wave generator consisting of an operational amplifier D1901 with feedback.
The oscillator frequency is determined by resistor R1909 and capacitor C1903. Capacitor C1902 keeps point 3 of the IC constantly equal to the average output voltage. Consequently, the generator is independent of fluctuations in the supply voltage. The square-wave amplitude is determined by zenerdiode V1901.
Potentiometer R1906 allows accurate adjustment of the output voltage and output current.
This output voltage is fed to socket X1 and the output current flows through current loop X2. This is the front panel CAL terminal.
The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

3.3. DISMANTLING THE INSTRUMENT

3.3.1. General information

Warning: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.
Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

This section provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During dismantling procedures, a careful note must be made of all disconnected leads so that they may be reconnected to their correct terminals during assembly.

The E.H.T. cable is unbreakably connected to the c.r.t. (disconnection at E.H.T. voltage multiplier i.e. unit 15). When the E.H.T. cable to the post-acceleration anode of the c.r.t. is disconnected at the E.H.T. unit end, the E.H.T. cable must be discharged immediately by shortening them to earth.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.

3.3.2. Removing the cabinet plates and the screen bezel

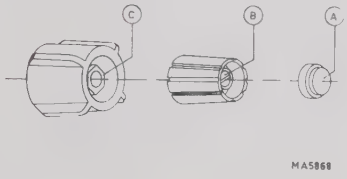
Both upper and lower cabinet plate can be removed after slackening one or two turns the four quick-release fasteners at the corners of each plate. Do not slacken the fasteners more than two turns, otherwise they may come apart.

The screen bezel can be dëtached by pressing the longer edges and pulling out.

3.3.3. Removing the knobs

3.3.3.1. Single knobs

- Prise off cap A
- Slacken screw (or nut) B
- Pull the knob from the spindle



3.3.3.2. Double knob

- Prise off cap A and slacken screw B
- Pull the inner knob from the spindle
- Slacken nut C and pull the outer knob from the spindle

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

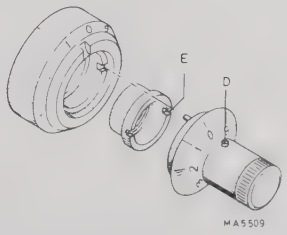


Fig. 3.18. Removing the knobs.

3.3.3.3. Delay-time multiplier knob

- Slacken screw D using a hexagonal key and pull the knob from the spindle
- Remove the nut E and withdraw the ring from the spindle.

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

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Subjects:

1. New trigger unit and a new mains filter in /02 and following series.
2. Improvement of adjustment procedure of vertical and horizontal amplifiers.
3. Improvement of adjustment procedure of storage section.
4. Survey of spare parts for pushbutton switches.

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1. NEW TRIGGER UNIT (UNIT 9) AND NEW MAINS FILTER (UNIT 3) IN /02 AND FOLLOWING SERIES.

1.1. Circuit description (see fig. 2).

Main time-base trigger amplifier

The main time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier. In this trigger amplifier, there is an output taken off for trigger view.

The signal current from the intermediate amplifier (channel A, channel B, or composite) is fed via the trigger source selector circuit to the emitter of V803. The output from the trigger source (EXT, EXT ÷ 10, or LINE i.e. mains frequency) is also fed to the emitter of V803. This transistor, connected in common-base configuration, is coupled to the shunt feedback stage V804, V806.
The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example the DC position, selected by switch S20, is switched in by the -11,4V which causes diodes V809 and V812 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V813, which compensates for the temperature drift of transistor V804.

On the trigger amplifier, the trigger view signal and the trigger signal proper are split up by means of two amplifier stages.
The two transistors V816 and V817 accept the trigger signal. The transistors V814 and V818 accept the trigger level voltage.
The LEVEL voltage control R7 permits variation of the trigger level of the signal.
The trigger view gain can be varied by means of preset potentiometer R842 in the emitter circuit of transistors V814 and V816.

The collectors of transistors V814 and V816 provide the trigger view output and the collector currents of transistors V817 and V818 are fed to the shunt feedback stage V821 and V822 respectively, thus providing the trigger signal.

In the negative position of the +/- SLOPE switch S7, the trigger signal is taken from one of the collectors via transistors V824 and V827 and in the positive position via transistors V823 and V826.

+/- SLOPE switch S7 determines the polarity of the trigger signal. In the closed position a 0V signal causes V827 to conduct the negative trigger, and also switches off V829. In the open position, V829 is switched on and the positive trigger is routed via V826 and V827 is blocked. In this way, the appropriate trigger signal appears at the combined emitters of transistors V826 and V827. This trigger signal is routed via a Schmitt-trigger formed by D802 (2-4-5), R894 and R895 to the flip-flop D901 in the main time-base sweep gating logic.

Delayed time-base trigger amplifier

The delayed time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier.

The signal current from the intermediate amplifier (channel A, channel B or composite) is fed via the trigger source selector circuit to the emitter of V1203. The output from the trigger source (EXT) is also fed to the emitter of V1203.
This transistor connected in common-base configuration, is coupled to the shunt feed-back stage V1204, V1206. The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example, the DC position, selected by switch S19, is switched in by the -11,4V which causes diodes V1208 and V1209 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V1212, which compensates for the temperature drift of transistor V1204.

The two transistors V1213 and V1214 accept the trigger signal and the trigger LEVEL voltage respectively.
The LEVEL voltage control R5 permits variation of the trigger level of the signal.
The collector currents of V1213 and V1214 are fed to the shunt feedback stage V1217 and V1218 respectively, thus providing the trigger signal.

In the negative position of the +/- SLOPE switch S6, the trigger signal is taken from one of the collectors via V1222 and transistor V1223, and in the positive position via V1219 and transistor V1221.

+/- SLOPE switch S6 determines the polarity of the trigger signal. In the closed position a 0V signal causes V1223 to conduct the negative trigger, and also switches off V1227. In the open position, V1227 is switched on and the positive trigger is routed via V1221 and V1223 is blocked. In this way the appropriate trigger signal is supplied to the time-base.

1.2. Checking and adjusting the trigger unit

Gain (sensitivity) external triggering via TRIG VIEW (unit 9)

- Depress push-button TRIG VIEW of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a 600mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV; if necessary, readjust potentiometer R842 on the trigger-amplifier board
- Remove the input signal.

Trigger balance main time-base (unit 16, unit 12, unit 9)

- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button HF of the m.t.b. trigger-coupling controls (S20)
- Set the m.t.b. LEVEL potentiometer in its mid position
- Centre the trigger view line with potentiometer R845 on the trigger amplifier p.c. board
- Depress push-button DC of the m.t.b. trigger coupling controls (S20)
- Check that the trigger view line remains in the screen centre; if necessary, readjust potentiometer R729 on the trigger source board
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Check that the trigger view-line remains in the screen centre; if necessary, readjust potentiometer R426 on the intermediate amplifier board
- Depress push-button B of the m.t.b. trigger-source controls (S22)
- Check that the trace remains in the screen centre; if necessary, readjust potentiometer R476 on the intermediate amplifier board
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave signal of 30mV, frequency 2kHz, to the m.t.b. EXT input
- Adjust the m.t.b. LEVEL potentiometer for a triggered display
- Check that the trigger view-line is written across the centre of the screen; if necessary, readjust potentiometer R527 on the intermediate amplifier board
- Remove the input signal.

Trigger balance delayed time-base (unit 12)

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the MAIN TIME/DIV switch to .5µs and its vernier to CAL
- Set the DEL'D TIME/DIV switch to .2µs and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to 20mV/DIV and its vernier to CAL
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120mV, frequency 1MHz, to input A
- Set the d.t.b. LEVEL potentiometer in its mid position
- Adjust R1238 on the trigger amplifier p.c. board for a triggered display
- Centre the display, using the channel A POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL potentiometer.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer R422 on the intermediate amplifier board.

- Depress push-button B of the display-mode controls (S1)
- Set the channel B AMPL switch to 20mV/DIV and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button B of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120mV, frequency 1MHz, to input B
- Centre the display, using the channel B POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL control.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer R472 on the intermediate amplifier board
- Remove the input signal.

Triggering

Trigger slope and level of the m.t.b. (unit 9)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the switch of the channel A input-coupling control to DC
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20mV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 10µs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 120mV$_{p-p}$, frequency 30kHz, to the channel A input
- Centre the display, using the POSITION control
- Centre the starting point of the sine-wave, using the m.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to -; if necessary, readjust potentiometer R881 on the trigger-amplifier board
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going edge of the sine-wave and moves upwards when the LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to its - position
- Check that the time-base generator starts on the negative-going edge of the sine-wave
- Set the channel A AMPL switch to 5mV/DIV
- Rotate the m.t.b. LEVEL control fully clockwise and fully anti-clockwise
- Check that in both extreme positions the time-base generator cuts out and that the NOT TRIG'D lamp lights up, if necessary readjust potentiometer R845 on the trigger amplifier.
- Increase the amplitude of the input signal to 160mV$_{p-p}$
- Rotate the m.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered and that the NOT TRIG'D lamp does not light up
- Remove the input signal.

SPARE PARTS LIST

Capacitors

C 801	4822 122 30043	10NF-20+80	40
C 802	4822 122 30043	10NF-20+80	40
C 803	4822 122 30043	10NF-20+80	40
C 804	4822 122 31056	12PF 2	100
C 806	4822 122 31081	100PF 2	100
C 807	4822 122 31081	100PF 2	100
C 808	4822 122 30043	10NF-20+80	40
C 809	4822 121 41161		
C 811	4822 122 30043	10NF-20+80	40
C 812	4822 122 31081	100PF 2	100
C 813	4822 122 30043	10NF-20+80	40
C 814	4822 122 31081	100PF 2	100
C 816	4822 122 31056	12PF 2	100
C 817	4822 122 30043	10NF-20+80	40
C 822	4822 122 30043	10NF-20+80	40
C 823	4822 124 20697	10UF-10+50	25
C 824	4822 122 31056	12PF 2	100
C 826	4822 122 30045	27PF 2	100
C 829	4822 122 30043	10NF-20+80	40
C 831	4822 122 30043	10NF-20+80	40
C 832	4822 122 30045	27PF 2	100
C 833	4822 122 31056	12PF 2	100
C 836	4822 122 31054	10PF 2	100
C 837	4822 122 31054	10PF 2	100
C 838	4822 122 30043	10NF-20+80	40
C 839	4822 122 31069	39PF 2	100
C 841	4822 122 30043	10NF-20+80	40
C 842	4822 124 20697	10UF-10+50	25
C 843	4822 122 30043	10NF-20+80	40
C 844	4822 122 30043	10NF-20+80	40
C 846	4822 122 30043	10NF-20+80	40
C 847	4822 122 30043	10NF-20+80	40
C 848	4822 124 20697	10UF-10+50	25
C 849	4822 122 30043	10NF-20+80	40
C 851	4822 122 30043	10NF-20+80	40
C 852	4822 124 20697	10UF-10+50	25
C 853	4822 122 30043	10NF-20+80	40
C 854	4822 122 30043	10NF-20+80	40
C 856	4822 124 20697	10UF-10+50	25
C 857	4822 122 30043	10NF-20+80	40
C 1201	4822 122 31081	100PF 2	100
C 1202	4822 122 30043	10NF-20+80	40
C 1203	4822 122 31081	100PF 2	100
C 1206	4822 122 30043	10NF-20+80	40
C 1207	4822 122 30043	10NF-20+80	40
C 1208	4822 122 31056	12PF 2	100
C 1209	4822 122 31056	12PF 2	100
C 1211	4822 121 41161		
C 1212	4822 122 30043	10NF-20+80	40
C 1213	4822 122 31081	100PF 2	100
C 1214	4822 122 31081	100PF 2	100
C 1216	4822 122 30043	10NF-20+80	40
C 1217	4822 124 20697	10UF-10+50	25
C 1218	4822 122 30043	10NF-20+80	40
C 1219	4822 122 31056	12PF 2	100
C 1223	4822 122 30043	10NF-20+80	40
C 1224	4822 122 30045	27PF 2	100
C 1226	4822 122 30045	27PF 2	100
C 1227	4822 122 31056	12PF 2	100
C 1228	4822 122 31056	12PF 2	100
C 1229	4822 122 31054	10PF 2	100
C 1231	4822 122 31056	12PF 2	100
C 1232	4822 122 31054	10PF 2	100
C 1233	4822 122 31069	39PF 2	100
C 1234	4822 122 30043	10NF-20+80	40
C 1236	4822 122 30043	10NF-20+80	40
C 1237	4822 122 30043	10NF-20+80	40
C 1238	4822 122 30043	10NF-20+80	40
C 1239	4822 122 30043	10NF-20+80	40
C 1321	4822 122 31081	100PF 2	100
C 1322	4822 122 30043	10NF-20+80	40
C 1323	4822 124 20697	10UF-10+50	25

Resistors

R 801	5322 116 54469	100	1	MR25
R 802	5322 116 54536	750	1	MR25
R 803	5322 116 50556	4,42K	1	MR25
R 804	5322 116 54541	825	1	MR25
R 805	5322 116 54469	100	1	MR25
R 806	5322 116 54525	511	1	MR25
R 807	5322 116 54536	750	1	MR25
R 808	5322 116 54469	100	1	MR25
R 809	5322 116 50492	46,4	1	MR25
R 811	5322 116 50527	33,2	1	MR25
R 812	5322 116 54585	3,48K	1	MR25
R 813	5322 116 54558	8,25K	1	MR25
R 814	5322 116 50527	33,2	1	MR25
R 816	5322 116 54511	316	1	MR25
R 817	5322 116 54442	51,1	1	MR25
R 818	5322 116 54442	51,1	1	MR25
R 819	5322 116 50635	1,47K	1	MR25
R 820	5322 116 54525	511	1	MR25
R 821	5322 116 50635	1,47K	1	MR25
R 822	5322 116 50558	18,7K	1	MR25
R 823	5322 116 50558	18,7K	1	MR25
R 824	5322 116 54469	100	1	MR25
R 825	5322 116 54525	511	1	MR25
R 826	5322 116 50635	1,47K	1	MR25
R 827	5322 116 50635	1,47K	1	MR25
R 828	5322 116 50558	18,7K	1	MR25
R 829	5322 116 50558	18,7K	1	MR25
R 830	5322 116 54469	100	1	MR25
R 831	5322 116 54469	100	1	MR25
R 832	5322 116 50635	1,47K	1	MR25
R 833	5322 116 50635	1,47K	1	MR25
R 834	5322 116 50558	18,7K	1	MR25
R 835	5322 116 50536	464	1	MR25
R 836	5322 116 50558	18,7K	1	MR25
R 837	5322 116 54442	51,1	1	MR25
R 838	5322 116 54442	51,1	1	MR25
R 839	5322 116 54541	825	1	MR25
R 841	5322 116 50459	422	1	MR25
R 842	5322 100 10135	470	20	0.75W
R 844	5322 116 50527	33,2	1	MR25
R 845	5322 100 10133	220	20	0.75W
R 846	5322 116 54516	365	1	MR25
R 847	5322 116 54516	365	1	MR25
R 848	5322 116 54545	909	1	MR25
R 849	5322 116 50766	147	1	MR25
R 851	5322 116 54545	909	1	MR25
R 852	5322 116 50491	22,6	1	MR25
R 853	5322 116 54469	100	1	MR25
R 854	5322 116 50569	95,3	1	MR25
R 855	5322 116 54469	100	1	MR25
R 856	5322 116 54536	750	1	MR25
R 857	5322 116 50569	95,3	1	MR25
R 858	5322 116 50527	33,2	1	MR25
R 859	5322 116 54541	825	1	MR25
R 861	5322 116 50527	33,2	1	MR25
R 863	5322 116 54502	261	1	MR25
R 864	5322 116 54426	121	1	MR25
R 865	5322 116 54192	5,11	1	MR25
R 866	5322 116 54426	121	1	MR25
R 867	5322 116 50527	33,2	1	MR25
R 868	5322 116 54511	316	1	MR25
R 869	5322 116 54513	332	1	MR25
R 870	5322 116 54469	100	1	MR25
R 871	5322 116 54466	90,9	1	MR25
R 872	5322 116 50491	22,6	1	MR25
R 873	5322 116 50593	16,2K	1	MR25
R 874	5322 116 54469	100	1	MR25
R 875	5322 116 50491	22,6	1	MR25
R 876	5322 116 50491	22,6	1	MR25
R 877	5322 116 50586	1,54K	1	MR25
R 878	5322 116 54534	681	1	MR25
R 879	5322 116 50586	1,54K	1	MR25
R 881	5322 100 10141	10K	20	0.75W

R 882	5322 116 54486	150	1	MR25
R 883	5322 116 54511	316	1	MR25
R 884	5322 116 54513	332	1	MR25
R 885	5322 116 54442	51,1	1	MR25
R 886	5322 116 54466	90,9	1	MR25
R 887	5322 116 50491	22,6	1	MR25
R 888	5322 116 50593	16,2K	1	MR25
R 889	5322 116 54469	100	1	MR25
R 890	5322 116 54192	5,11	1	MR25
R 891	5322 116 50491	22,6	1	MR25
R 892	5322 116 50491	22,6	1	MR25
R 893	5322 116 54511	316	1	MR25
R 894	5322 116 54442	51,1	1	MR25
R 895	5322 116 50506	154	1	MR25
R 896	5322 116 54504	274	1	MR25
R 897	5322 116 54511	316	1	MR25
R 898	5322 116 54549	1K	1	MR25
R 899	5322 116 54619	10K	1	MR25
R 1201	5322 116 54585	3,48K	1	MR25
R 1202	5322 116 54558	8,25K	1	MR25
R 1203	5322 116 54511	316	1	MR25
R 1204	5322 116 50527	33,2	1	MR25
R 1206	5322 116 50527	33,2	1	MR25
R 1207	5322 116 50492	46,4	1	MR25
R 1208	5322 116 54469	100	1	MR25
R 1209	5322 116 54469	100	1	MR25
R 1211	5322 116 54469	100	1	MR25
R 1212	5322 116 54525	511	1	MR25
R 1213	5322 116 54536	750	1	MR25
R 1214	5322 116 54536	750	1	MR25
R 1216	5322 116 54525	511	1	MR25
R 1217	5322 116 54525	511	1	MR25
R 1218	5322 116 54442	51,1	1	MR25
R 1219	5322 116 54442	51,1	1	MR25
R 1221	5322 116 50635	1,47K	1	MR25
R 1222	5322 116 50635	1,47K	1	MR25
R 1223	5322 116 50558	18,7K	1	MR25
R 1224	5322 116 50558	18,7K	1	MR25
R 1226	5322 116 54469	100	1	MR25
R 1227	5322 116 50635	1,47K	1	MR25
R 1228	5322 116 50635	1,47K	1	MR25
R 1229	5322 116 50558	18,7K	1	MR25
R 1231	5322 116 50558	18,7K	1	MR25
R 1232	5322 116 54469	100	1	MR25
R 1233	5322 116 50635	1,47K	1	MR25
R 1234	5322 116 50635	1,47K	1	MR25
R 1236	5322 116 50558	18,7K	1	MR25
R 1237	5322 116 50558	18,7K	1	MR25
R 1238	5322 116 54534	681	1	MR25
R 1239	5322 116 54469	100	1	MR25
R 1241	5322 116 50491	22,6	1	MR25
R 1242	5322 116 54469	100	1	MR25
R 1243	5322 116 54536	750	1	MR25
R 1244	5322 116 54448	59	1	MR25
R 1246	5322 116 50527	33,2	1	MR25
R 1248	5322 116 54541	825	1	MR25
R 1249	5322 116 50527	33,2	1	MR25
R 1251	5322 116 54502	261	1	MR25
R 1252	5322 116 54426	121	1	MR25
R 1253	5322 116 54426	121	1	MR25
R 1254	5322 116 50527	33,2	1	MR25
R 1256	5322 116 54511	316	1	MR25
R 1257	5322 116 54513	332	1	MR25
R 1258	5322 116 54466	90,9	1	MR25
R 1259	5322 116 50491	22,6	1	MR25
R 1261	5322 116 54469	100	1	MR25
R 1262	5322 116 54532	649	1	MR25
R 1263	5322 116 54532	649	1	MR25
R 1264	5322 116 54511	316	1	MR25
R 1266	5322 116 54513	332	1	MR25
R 1267	5322 116 54466	90,9	1	MR25
R 1268	5322 116 50491	22,6	1	MR25
R 1269	5322 116 54469	100	1	MR25
R 1271	5322 116 50593	16,2K	1	MR25
R 1272	5322 116 54511	316	1	MR25
R 1273	5322 116 54469	100	1	MR25
R 1274	5322 116 50491	22,6	1	MR25
R 1276	5322 116 50491	22,6	1	MR25
R 1277	5322 116 54486	150	1	MR25
R 1278	5322 116 54442	51,1	1	MR25
R 1279	5322 116 50506	154	1	MR25

R 1281	5322 116 54504	274	1	MR25
R 1282	5322 116 50491	22,6	1	MR25
R 1283	5322 116 54469	100	1	MR25
R 1284	5322 116 50491	22,6	1	MR25
R 1286	5322 116 54469	100	1	MR25
R 1287	5322 116 50593	16,2K	1	MR25
R 1288	5322 116 54511	316	1	MR25
R 1289	5322 116 54549	1K	1	MR25
R 1291	5322 116 54619	10K	1	MR25
R 1292	5322 116 54442	51,1	1	MR25
R 1293	5322 116 54525	511	1	MR25
R 1371	5322 116 54469	100	1	MR25
R 1372	5322 116 54469	100	1	MR25
R 1373	5322 116 50527	33,2	1	MR25
R 1374	5322 116 50527	33,2	1	MR25
R 1376	5322 116 54595	5,11K	1	MR25
R 1377	5322 116 54005	3,32K	1	MR25
R 1378	5322 116 50479	15,4K	1	MR25
R 1379	5322 100 10113	10K	20	0,5W
R 1381	5322 116 50527	33,2	1	MR25
R 1382	5322 116	5K62	1	MR25
R 1383	5322 116 50675	2,26K	1	MR25
R 1384	5322 100 10113	10K	20	0,5W

Diodes and transistors

V 801	4822 130 44358	BC559B
V 802	5322 130 30691	BAW56
V 803	5322 130 44711	BFT92
V 804	5322 130 44713	BFT92R
V 806	5322 130 44178	BFR92
V 807	5322 130 44396	BF324
V 808	4822 130 30613	BAW62
V 809	5322 130 30691	BAW56
V 811	4822 130 30613	BAW62
V 812	5322 130 30691	BAW56
V 813	5322 130 44713	BFT92R
V 814	5322 130 44606	BFR92R
V 816	5322 130 44178	BFR92
V 817	5322 130 44178	BFR92
V 818	5322 130 44606	BFR92R
V 819	5322 130 34337	BAV99
V 821	5322 130 44178	BFR92
V 822	5322 130 44606	BFR92R
V 823	5322 130 44606	BFR92R
V 824	5322 130 44178	BFR92
V 826	5322 130 44713	BFT92R
V 827	5322 130 44713	BFT92R
V 828	4822 130 30613	BAW62
V 829	4822 130 44246	BC549C
V 831	4822 130 30613	BAW62
V 1201	5322 130 44396	BF324
V 1202	5322 130 30691	BAW56
V 1203	5322 130 44713	BFT92R
V 1204	5322 130 44711	BFT92
V 1206	5322 130 44606	BFR92R
V 1207	4822 130 30613	BAW62
V 1208	5322 130 30691	BAW56
V 1209	5322 130 30691	BAW56
V 1211	4822 130 30613	BAW62
V 1212	5322 130 44711	BFT92
V 1213	5322 130 44606	BFR92R
V 1214	5322 130 44178	BFR92
V 1216	5322 130 34337	BAV99
V 1217	5322 130 44606	BFR92R
V 1218	5322 130 44178	BFR92
V 1219	5322 130 44606	BFR92R
V 1221	5322 130 44711	BFT92
V 1222	5322 130 44178	BFR92
V 1223	5322 130 44711	BFT92
V 1224	4822 130 30613	BAW62
V 1226	4822 130 30613	BAW62
V 1227	4822 130 44246	BC549C

Integrated circuits

D 801	5322 209 84659	LM308T
D 802	5322 209 86012	GXB10104P
D 1201	5322 209 84659	LM308T
D 1304	5322 209 84659	LM308T

Starting with the /02 version, the under mentioned units will have different service ordering numbers.

UNIT 3	MAINS FILTER	5322 121 44262
UNIT 9	TRIGGER AMPLIFIER	5322 216 54225

In the manual some faulty code numbers are published:

Page 180, item 3.6.3., Coax. cable per meter,
Ordering code should be 5322 320 10004.

Page 183, item 1, Contrast filter blue,
Ordering code should be 5322 480 34074.

Page 186, S1, Vertical display mode switch,
Ordering code should be 5322 276 64029.

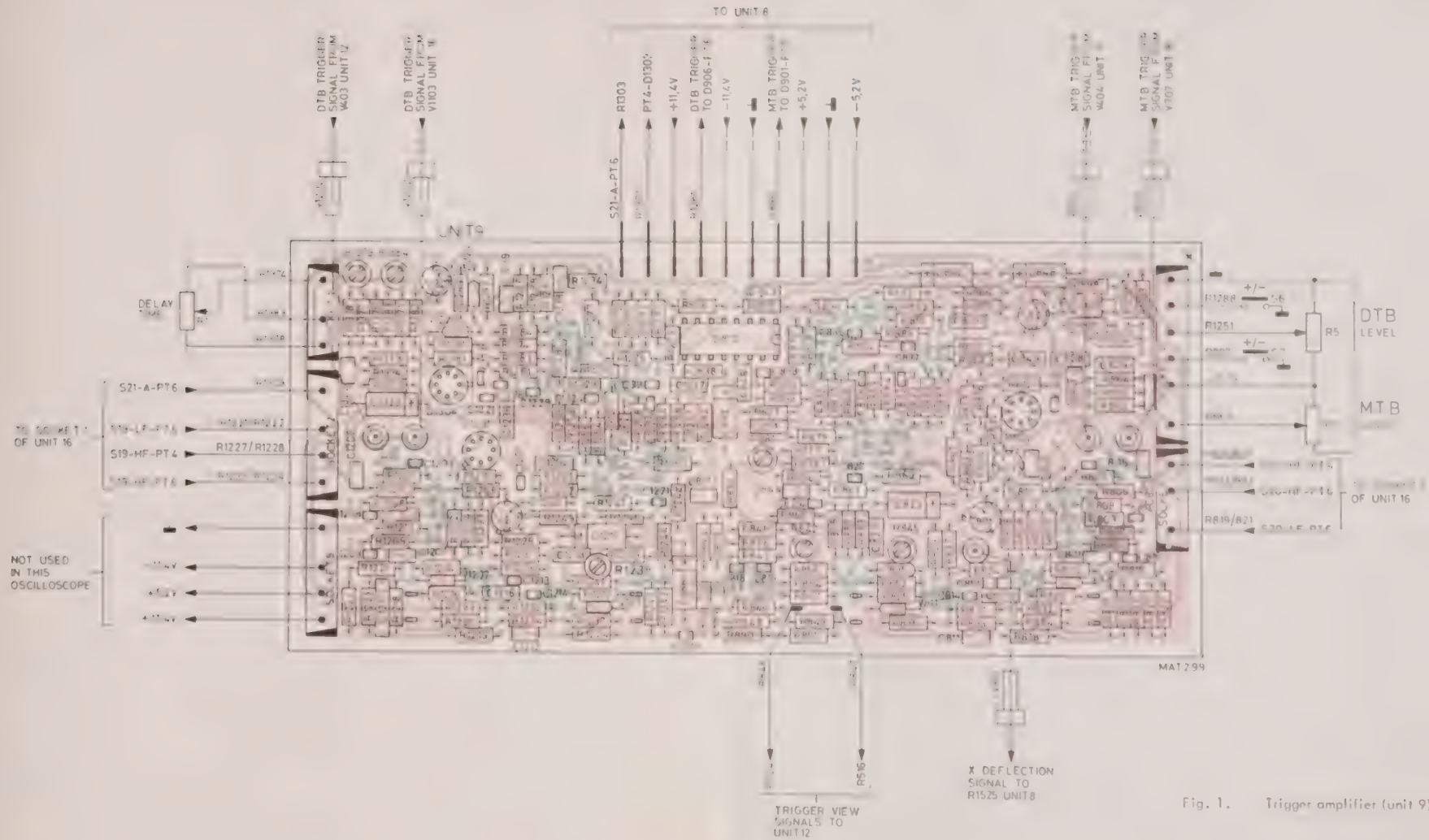

Fig. 1. Trigger amplifier (unit 9)

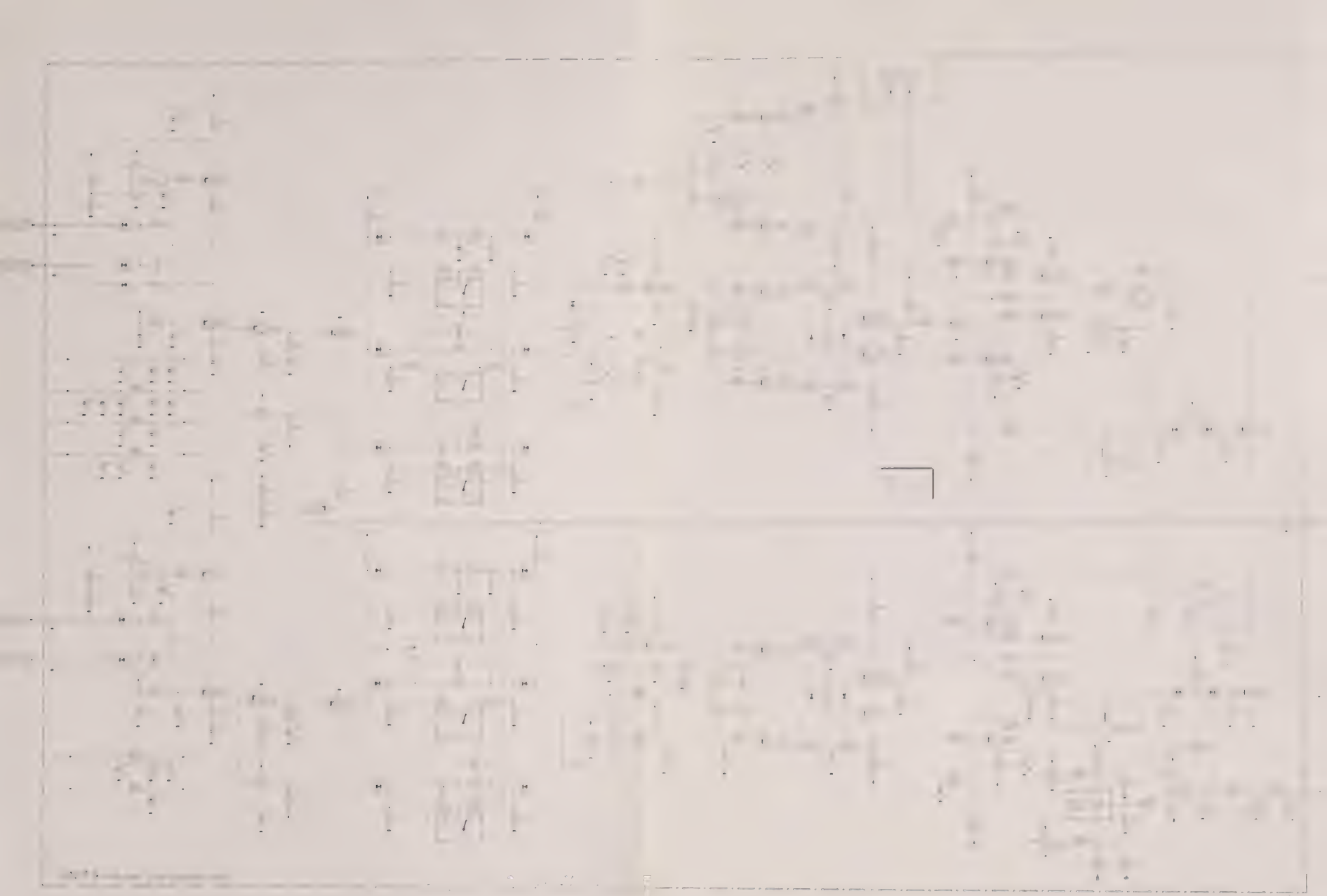

Fig. 2. Circuit diagram trigger amplifier

2. IMPROVEMENT OF ADJUSTMENT PROCEDURE OF VERTICAL AND HORIZONTAL AMPLIFIERS

2.1. EXT X DEFL balance adjustment (R1530 on time base unit and R737 on MTB and DTB external input unit).

Resistor R1530 and R737 are placed on soldering tags and are used as adjustment resistors. In conjuction with this the following modifications are carried out in the circuitry:

- On the time base unit (unit 8) R1523 has become a fixed 5,11 k resistor. An extra resistor R1530 (value between 5,11 k and 10 k) is added between V1519/base and -11,4V supply voltage.
- On the MTB and DTB external input unit (unit 16) R737 has become a resistor in the range between 2,15 k and 4,64 k.

The adjustment of R1530 and R737 must be carried out before the gain of the trigger unit is adjusted.

The balance adjustment must be carried out as follows:

- Display a time base line on the screen using the AUTO mode and switch on channel A without input signal.
- Adjust the time base line so with the X POSITION control that it starts at the beginning of the horizontal graticule.
- Depress the EXT X DEFL pushbutton of the horizontal deflection mode selector.
- Depress pushbutton A or B of the main time base trigger source selector.
- Check that the spot is in the horizontal mid of the screen (± 1 div.). If not select in the range between 5,11 k and 10 k the value for R1530 giving the best result between 5,11 k and 10 k.
- Depress pushbutton EXT of the main time base trigger source selector.
- Put the X AMPL control in the calibrated position.
- Check that the spot is at the beginning of the horizontal graticule (± 1 div.). If not select the value for R737 giving the best result in the range between 2,15 k and 4,64 k.

2.2. Y-position correction and ADD balance adjustment (R505 on unit 12 and R658 on unit 13).

This procedure replaces the procedure 3.4.7.8. on page 152 of the manual. In order to make this possible R502 is changed into a fixed value of 147E.
In parallel with R502 an adjustment resistor R505 must be mounted on soldering tags. Resistance range between 2,05 k and 5,62 k. The adjustment procedure must be carried out as follows:

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the x-deflection controls (S2)
- Set the vertical POSITION potentiometer to its mid-position
- Short-circuit the input of the delay-line on the intermediate amplifier board (unit 12)
- Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust potentiometer R658 on the final y-amplifier board.
- Remove the short-circuit on the intermediate amplifier board
- Depress push-button ALT of the display-mode controls (S1)
- Shift the A and B traces in opposite direction, by means of the POSITION controls.
- Depress push-button ADD of the display-mode controls (S1).

- Adjust resistor R505 (2,05 k ... 5,62 k) on the intermediate amplifier so that the trace appears in the centre of the screen.
- Depress push-button ALT of the display-mode controls (S1)
- Shift both traces to the centre of the screen with the POSITION controls
- Depress push-button ADD of the display-mode controls (S1)
- Readjust resistor R505 for minimum trace jump.
  If necessary, repeat this procedure.

2.3. Sensitivities and L.F. corrections

This adjustment procedure replaces the procedures 3.4.9. and 3.4.10.1. starting on page 154 in the manual.

2.3.1. L.F. correction amplifier (attenuator unit)

- Depress push-button A (B) of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button DC of the channel A (B) signal-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the channel A (B) AMPL switch to 10mV/DIV and its vernier to CAL
- set the m.t.b. TIME/DIV switch to .5ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60mV, repetition rate 200Hz, to the channel A (B) input
- Check that the pulse top is straight; if necessary, readjust potentiometer R132 (ch. A) or R182 (ch. B) on the attenuator board.

2.3.2. L.F. correction MTB external input (R736)

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the MTB trigger source selector S22
- Depress push-button DC of the MTB trigger coupling switch S20
- Set the MTB TIME/DIV switch in the 0,5mV/DIV. position
- Set the DTB TIME/DIV switch in the OFF position
- Apply a 2kHz/600mV square-wave signal to the MTB external input socket X7
- Position the wave form on the screen by means of the MTB level control R7
- Check that the pulse top is straight; if not adjust R736 on the trigger source unit (unit16)
- Remove the input signal

2.3.3. L.F. correction DTB external input (R1118)

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the DTB trigger source selector S21
- Depress push-button DC of the DTB trigger coupling switch S19
- Set the MTB TIME/DIV switch in the 0,5ms/DIV position
- Set the DTB TIME/DIV switch in the OFF position
- Switch the instrument off and change on unit 9 the coax cables for the MTB and DTB trigger signals from unit 16
- Switch the instrument on again
- Apply a 2kHz/600mV square wave signal to the DTB external input socket X6
- Position the waveform on the screen by means of the MTB level control R7
- Check if the pulse top is straight; if not adjust R1118 on the trigger source unit (unit 16)
- Switch the instrument off and change the coax cables for the MTB and DTB trigger signals again
- Switch the instrument on again
- Remove the input signal

2.3.4. Gain (sensitivity) Y_A VIA Y (unit 13)

- Set front panel GAIN potentiometer R12 in its mid position
- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling controls to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV to 0,2ms/DIV
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Check that the trace-height is 6 DIV; if necessary, readjust potentiometer **R654** on the **final Y amplifier board**
- Check that the control range of the channel A vernier control is 1 : 2,6 to 1 : 3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of the CAL position

2.3.5. Gain (sensitivity) Y_B VIA Y

- Depress push-button B of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling controls to AC
- Depress push-button B of the m.t.b. trigger-source controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Check that the trace height is 6DIV; if necessary, readjust GAIN potentiometer R13 on the front panel
- Check that the control range of the channel B AMPL vernier control is 1 : 2,6 to 1 : 3,5 and the pilot lamp UNCAL light up as soon as the vernier is out of the CAL position
- Remove the input signal

2.3.6. Gain (sensitivity) at external X deflection (unit 16)

- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the X AMPL-HOLD OFF control to CAL
- Apply a 300mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Check that the trace width is 6 DIV; if necessary, readjust potentiometer **R742** on the **trigger-source board**
- Check that the control range of the X AMPL-HOLD OFF control is 1 : 2,6 to 1 : 3,5
- Set the X AMPL-HOLD OFF control to CAL
- Depress push-button EXT ÷ 10 (S22) of the m.t.b. trigger source controls
- Increase the amplitude of the input signal by a factor of 10
- Check that the trace width is 6 DIV ± 2 SUBDIV
- Remove the input signal

2.3.7. Gain (sensitivity) external triggering via TRIG VIEW (unit 9)

- Depress push-button TRIG VIEW of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a 600mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV; if necessary, readjust potentiometer **R852** on the **trigger-amplifier board**
- Remove the input signal

2.3.8. Gain (sensitivity) Y_A TRIG VIEW

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Depress push-button A (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Centre the display, using the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer R410 on the intermediate amplifier board. For the location of R410 see fig. 3.

2.3.9. Gain (sensitivity) Y_BTRIG VIEW

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel B AMPL switch to 0.5V/DIV and its vernier to CAL
- Depress push-button B (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Centre the display, using the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer R460 on the intermediate amplifier board. For the location of R460 see fig. 3.

2.3.10. Gain (sensitivity) Y_A VIA X

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling controls to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Check that the trace width is 6DIV ± 0,3 DIV

2.3.11. Gain (sensitivity) Y_B VIA X

- Depress push-button A of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling controls to AC
- Depress push-button B S22 of the m.t.b. trigger-source controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Check that the trace width is 6 DIV ± 1 SUBDIV.
- Remove the input signal

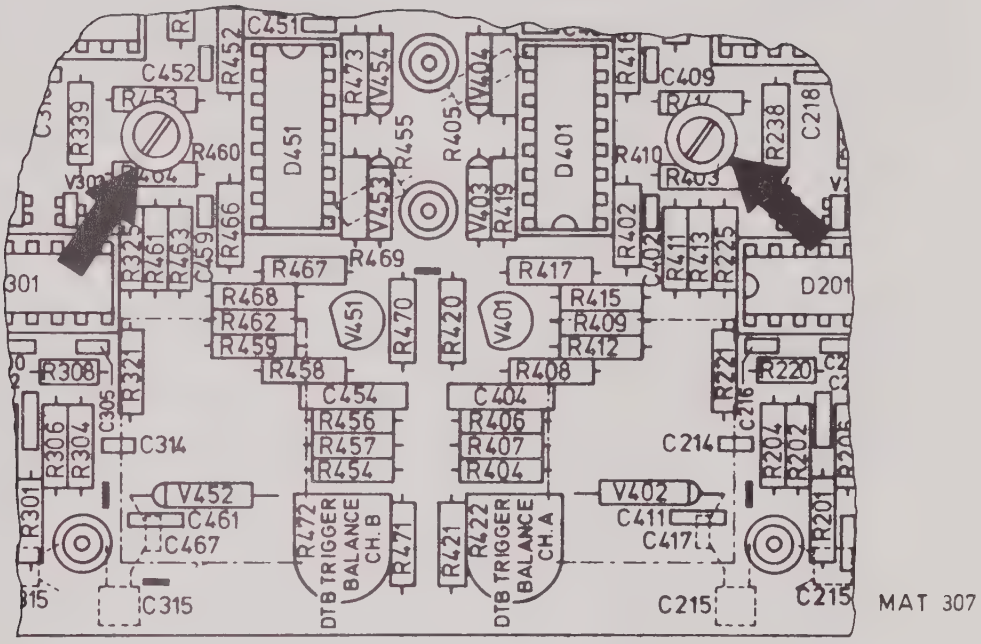

Fig. 3. *Detail of lay-out of intermediate amplifier (unit 12) showing R410 and R460.*

3. IMPROVEMENT OF ADJUSTMENT PROCEDURE OF STORAGE SECTION (unit 22 and unit 25).

3.1. Introduction

This procedure gives a quicker result than the procedure in section 3.4.16. on page 167 of the manual. The voltage levels to be adjusted are indicated V1 till V8.
These voltage levels are indicated in the manual in fig. 3.29. for the WRITE or VARIABLE PERSISTENCE mode and in fig. 3.30. for the FAST mode. For the MEMORY OFF and the STORE mode there are no adjustments to be done.
When measuring voltage levels on the front mesh take care that the measuring oscilloscope and probe can withstand 500 Volt pulses.

3.2. Checking the writing speed

The adjustments that have to be done are necessary to obtain the specified writing speed at a good quality of the picture. This chapter explains how to measure the writing speed over the entire screen.

A sinewave with an amplitude of A divisions and a frequency f has a writing speed $V = 2.\pi.f.A.$ divisions per second at zero crossing; π is approx. 3.14. When a signal giving 32 divisions peak-peak deflection is applied to the vertical input; it can be regarded that the zero crossing of this signal covers the entire screen area. The time base TIME/DIV. switch must be adjusted to about ten periods of the signal on the screen.

When using the formula stated above the following values can be calculated:

- In the WRITE mode the writing speed is specified at 0,25 DIV/μs in the single shot mode. When a signal is applied giving 32 divisions vertical deflection the amplitude is 16 divisions. The frequency now can be calculated: f = 2,5 kHz.
- In the MAX WRITE mode the writing speed must be 2,5 DIV/μs and therefore f = 25kHz.
- In the FAST mode the writing speed must be 1000 DIV/μs and therefore f = 10MHz.

3.3. Adjustment of the WRITE or VARIABLE PERSISTENCE mode:

- Turn R2404 and R2523 fully clockwise, R2427 fully counter clockwise.
- Connect the probe of the measuring oscilloscope to the front mesh terminal 12 on unit 25. The measuring terminals for the storage electrodes are located near connector S2.
  Turn the persistence control (R16) fully counter clockwise so that the dynamic erase pulses on the front mesh are switched on.
  Adjust the amplitude of these pulses by means of R2423 to 8 Volt.
- Adjust the store level V1 (the lower level of the dynamic erasure pulses) on the front mesh to 0 Volt by means of R2577.
  Remove the probe.
  The pulses can be measured with the oscilloscope itself.
  The store level is normally 0 Volt; however in some cases a voltage that is somewhat different from this gives a better result!
- Turn the intensity control (R14) to minimum.
  Turn the persistence control (R16) to its first clockwise stop (not in the MAX position) so that the dynamic erase pulses on the front mesh are switched off.
  Adjust the voltage on collimator 2 to the lowest possible value by means of R2523. The borders of the illuminated area on the CRT screen must be just invisible, when releasing the erase button.

- Operate the erase pushbutton (S25) and adjust by means of R2427 the erase pulse voltage V2 so that the CRT screen is just black.
  Repeat this procedure to obtain optimum result.

- In the MAX WRITE position the storage level is increased a little and the background illumination on the CRT screen can be adjusted to the desired value by means of R2414.

- The illumination of the left half and the right half of the CRT screen must be equal. This must be adjusted by means of R2549, which determines the cathode current of the left and the right flood gun system.

- Check that the specified writing speeds in WRITE and MAX WRITE mode are obtained.

3.4. Adjustment of the FAST mode:

- Adjust the instrument in the MEMORY OFF mode in such a way that a 10MHz/8 DIV. sinewave gives stable triggering. Switch after that to the FAST mode.

- Turn R2408, 2412, 2419 and 2429 fully counter clockwise.

- Turn the intensity control to minimum. Depress the erase button and adjust by means of R2429 the erase pulse voltage so that the CRT screen is nearly just black; a small rest of background illumination is advisable.

- Turn the intensity control at maximum and increase the amplitude of the 10MHz signal to 32 divisions. Operate the erase button and adjust by means of R2412 the voltage V5 so that the signal becomes visible. Adjust R2412 for optimum result. Readjustment of the focus could be necessary.

- Adjust the pulse voltage on the collimator 3 by means of R2404 to an equal background illumination over the whole screen.
  Repetitive erasure and adjustment is necessary to obtain an optimum result.

- Operate the erase button and write a signal immediately.
  Remember the recorded picture.
  Turn the trigger level R7 fully to the left or right so that the time base is not triggered. Operate the erase button and wait 10 seconds. Turn R7 back and write the signal.
  Now compare the two pictures. If the second picture has a lower intensity, turn R2408 clockwise and repeat the procedure; readjustment of R2412 could be possible. Repeat the adjusting procedure in order to obtain a stable functioning.

- Small readjustments of R2412, 2429 and 2404 could be necessary to obtain optimum result.

- Readjust, if necessary, the balance potentiometer R2549.

- Adjustment of R2419 is not necessary, fully counter clockwise is sufficient.

- If after adjustment of the storage section the writing speed is insufficient the adjustment of the writing gun must be checked.
  The adjustment is correct if:

  1. A sine wave signal of 10MHz and 8 divisions height can be written.
  2. The modulation pulse on G1 of the CRT during writing, in position magn. X10 (S3) is at least 75V.
     To avoid excessive voltages, the modulation pulse can be measured at the emitter of V2013 on the Z amplifier.
  3. The defocussing in horizontal direction on the left half and right half of the CRT screen is minimal and symmetrical.

4. SURVEY OF SPARE PARTS FOR PUSH-BUTTON SWITCHES

The following code numbers for push-button switch units are published in the manual:

S1 : 5322 276 64029
S2 : 5322 276 44063
S8 : 5322 276 34043
S19, S20 : 5322 276 64031
S21, S22 : 5322 276 84063

The code numbers mentioned above will be replaced in future by a collection of spare parts. With these parts it is possible to compose every desired switch unit. The parts that are necessary for the PM 3266 are:

a) Dual change over switch with spring for use with a reset bar.
Ordering code: 5322 276 14101.
In each instrument there are 30 pieces.

b) Dual change over switch with spring for use with reset bar (release key for single shot function).
After having been depressed the push-button returns to its rest position.
Ordering code: 5322 276 14359.
In each instrument 1 piece.

c) Reset bar for max. 6 switches.
The bar can be used for max. 6 switches that have a distance of 10,16mm from each other.
When the bar is needed for a unit with e.g. four switches it must be sawn to the required size.
When doing this take care that the distance between the last stud and the end of the bar is exactly 4,1mm.
When one switch in a unit needs no reset bar (e.g. an independent switch such as "erase") then remove at the relevant spot the stud from the bar with a pair of pincers.
The spring for the reset bar will be delivered together with the switch segments.
Ordering code: 5322 278 74007.
In each instrument there are 7 pieces.

d) Supports for max. 6, 11 and 12 switches.
The supports can be sawn to the required size.
Ordering code:

Max. 6 switches	: 5322 466 85841	Notch distances 4 x 10,16mm and 1 x 25,4mm.
Max. 11 switches	: 5322 466 85843	Notch distances 10 x 10,16mm.
Max. 12 switches	: 5322 466 85842	Notch distances 10 x 10,16mm and 1 x 25,4mm.

3.3.4. Removing units on the bottom side of the instrument

3.3.4.1. Storage logic (Unit 22)

- This unit is equipped with MOS devices that are very sensitive to static discharges. To ensure safe handling refer to chapter 3.2.8.: "Handling MOS Devices".
- Pull of the knobs from R14, R16 and R17.
- Remove the long shaft from R14.
- Remove two clamping pieces that attach the unit to the front panel.
- Unplug the stocks plugs, coax plugs and other connections.
- Pull the LED out off the front panel.
- Slacken three screws and take the unit out of the instrument.

3.3.4.2. Attenuator (Unit 2)

- Remove the shielding plate at the bottom side of the attenuator (remove 8 screws).
- Unplug the appropriate multipole connectors and coaxial cables.
- Remove the V/DIV attenuator knob.
- Remove the two Allen-key screws, which clamp the attenuator at the bottom side to the front-panel.
- Remove the two central nuts which clamp the attenuator to the frontpanel.
- The attenuator can be removed by shifting it backwards and have it leaving the instrument via the bottom side.

3.3.4.3. Trigger source selector (Unit 16)

- Unplug the four multipole connectors.
- Remove the two hexagon screws that secure the board to the front panel.
- Unscrew the two screws at the rear side of the board.
- Unsolder the wires at the components side of the board.
- Unplug the two miniature coaxial plugs at the soldering side of the board.
- Carefully lift the unit out of the oscilloscope.

3.3.4.4. Intermediate amplifier (Unit 12)

- Remove the various plugs.
- Unscrew the screws that secure the unit to the chassis.
- Unsolder the delay line connections.

3.3.4.5. Z-amplifier (Unit 11)

- Remove the black metal screening plate.
- Desolder 7 connections coming from the focus unit.
- Unplug the stocko plugs, coax plugs, and other connections.
- Remove three distance pieces and one screw and take the unit out.

3.3.4.6. Additional power supply (Unit 24)

- Remove the black metal screening plate.
- Unplug the stocko plugs and other connections.
- Remove four screws and take the unit out.
- When mounting the unit, don't forget to mount the earth tap for focus and EHT unit !!

3.3.4.7. Focus unit (Unit 7)

- Remove the black metal screening plate.
- Desolder seven connections on the Z-amplifier unit.
- Remove the rear plate and gently take off the CRT socket.
- Unplug the −3 kV plugs on the additional power supply unit.
- Unplug the connections on the power supply.
- Remove the remaining connections.
- Unscrew six screws and take the unit out of the instrument.

3.3.4.8. E.H.T. unit (Unit 15)

- Remove the black metal screening plate.
- Unplug the two single-wire connectors to the power supply board (unit 5).
- Disconnect the E.H.T. connector after unscrewing the swivel nut and discharge the cable.
- To extract the E.H.T. unit, swivel out by applying slight pressure to one side of this unit.
- Before screwing the E.H.T. cable on to a replacement E.H.T. unit, the E.H.T. connector should be greased with Silicon Dielectric Compound. Order no. 4822 390 20023.

3.3.5. Removing the power supply (Unit 5)

- Remove the lower cabinet plate.
- Remove the rear plate of the instrument (2 screws).
- Remove the black metal screening plate.
- Remove the two screws which secure the circuit board to the rear panel.
- Remove the two screws which secure the circuit board to the bottom side of its compartment.
- Unplug the three multipole connectors and disconnect the two single-wire connectors to the FOCUS p.c. board (unit 7).
- Disconnect the two single wire connectors to the E.H.T. voltage multiplier (unit 15).
- Carefully withdraw the circuit board from its compartment.

3.3.6. Removing units on the top side of the instrument.

3.3.6.1. Storage amplifier (Unit 25)

- This unit is equipped with MOS devices that are very sensitive to static discharges. In order to ensure safe handling refer to chapter 3.2.8.: "Handling MOS Devices".
- Unplug stocko plugs and other connections.
- Unscrew three screws.
- Remove high tension shield and distance piece and take the unit out of the instrument.

3.3.6.2. Trigger amplifier unit (Unit 9)

- Unplug stocko plugs, coax plugs and other connections.
- Unscrew three screws.
- Gently slide the unit out of the connector on the time-base unit.

3.3.6.3. Final X-amplifier (Unit 26)

- Unplug stocko plugs and other connections.
- Unplug very carefully the three CRT connections.
- Unscrew two screws and gently slide the unit out of the connector on the time-base unit.

3.3.6.4. Time-base unit (Unit 8)

- Remove the trigger amplifier as described in section 3.3.6.2.
- Remove the final X-amplifier as described in section 3.3.6.3.
- Unplug stocko plugs, coax plugs and other connections.
- Unscrew five screws and take the unit out of the instrument.

3.3.6.5. Final Y-amplifier (Unit 13)

- Remove the two screws which secure the bracket to the side strip.
- Disconnect the miniature coaxial plugs.
- Unplug the multipole connector.
- Remove the delay-line connections.
- Disconnect the wires from the C.R.T.-pins and carefully lift out the circuit board.

3.3.6.6. Delay line (Unit 4)

- Remove the connections on intermediate amplifier and final Y-amplifier.
- Unscrew two screws and take the delay line out of the instrument.

3.3.7. Removing the cathode ray tube (CRT)

Attention: Be very careful with the side connections of the CRT. If these pins are bent, the CRT is likely to develop a gas leak.

- Remove the top cover, bottom cover, black metal screening plate and the rear plate.
- Carefully remove the CRT side connections.
- Unplug the stocko plug that connects the CRT storage electrodes with the storage amplifier unit.
- Disconnect the trace rotation wires on the final X-amplifier.
- Disconnect the EHT cable and discharge it.
- Remove the tube base.
- Remove the screen bezel by pulling the lower edge.
- Remove the final X-amplifier as described in section 3.3.6.3.
- Remove the final Y-amplifier as described in section 3.3.6.5.
- Slacken the two screws that secure the upper CRT screen support to the front panel and disconnect the earth connection for the CRT shield.
- Slacken the brace round the CRT neck.
- Remove the two screws that connect the rubber CRT holder to the rear panel.
- Carefully slide the screen side of the CRT into the shield
- Now there is enough space to take the CRT, shield and rubber socket upwards out of the instrument.
- Now the CRT, shield and socket can be separed.

Attention: If the rubber socket round the CRT neck must be slid over the neck of a replacement tube, the use of industrial talcum powder is strongly recommended to prevent the rubber socket from sticking on the CRT neck.

3.3.8. Replacing a push-button switch

Each of the push-button sets is fitted to the front panel by means of two clamping devices secured by hexagon screws, see Fig. 3.19.

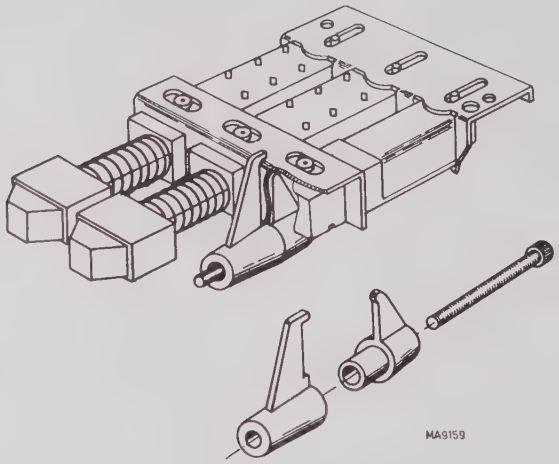

Fig. 3.19. Push-button set clamping device

To remove a push-button switch, the hexagon screws that secure it to the front panel must be removed. To replace one switch-section of a push-button set, refer to Fig. 3.20.

To remove a push-button switch which is mounted on a p.c. board:

- Remove the printed-circuit board for replacing a switch in this unit
- Straighten the 4 retaining lugs of the relevant switch as shown in Fig. 3.20.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-circuit board.
- Band the 4 retaining lugs back to their original positions.

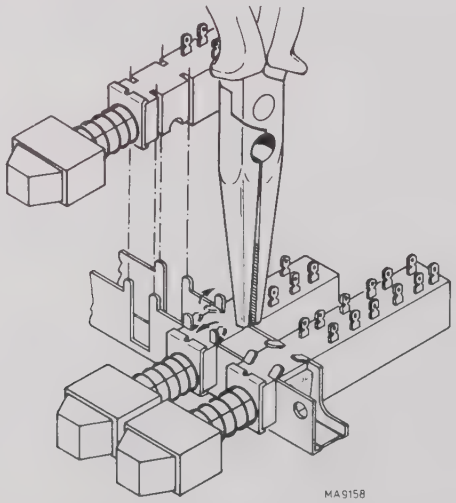

Fig. 3.20. Replacing a switch-segment of a push-button set

Note: Before a push-button switch is refitted to the front panel, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate replacement, refer to Fig. 3.19.

3.3.9. Removing the carrying handle

1. Remove the upper and lower cabinet plates
2. Remove the plastic strip which is snapped on to the grip
3. Remove the four screws which secure the grip to the brackets (these screws have been locked with a sealing varnisch).
4. Depress the push-buttons in the brackets and turn the carrying handle as far as possible to the upper side of the oscilloscope
5. Keep the push-button of the right-hand bracket depressed and pull the bracket from its bearing[1)]
6. Remove the grip from the remaining bracket
7. Depress the push-button of the left-hand bracket and turn the latter as far as possible to the lower side of the instrument.
8. Keep the push-button depressed and pull the bracket from its bearing.

If it is impossible to remove the left-hand bracket in this way, remove also its bearing in a similar way as described in footnote 1).

---

1) With some instruments it may be impossible to remove the handle in the described way. This is due to an extra securing plate in the right-hand bearing. In that case, DO NOT USE FORCE, but work in accordance with the following procedure which replaces points 3, 4 and 5.

3. Remove the two screws which secure the grip to the right-hand bracket
4. Remove the two hexagonal bolts which secure the right-hand bearing to the side strip.
5. Depress the push-button of the right-hand bracket and take the bearing from the bracket.

3.3.10. Soldering micro-miniature semi-conductors

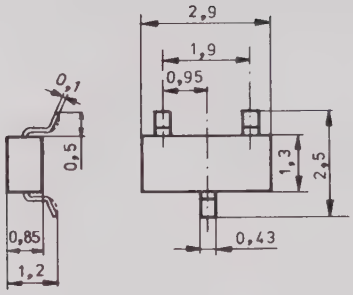

Fig. 3.21. Dimensional drawing SOT-23

Because of the small dimensions of these SOT semi-conductors and the lack of space between the components on the printed-circuit board, it is necessary to use a miniature soldering iron with a pin-point tip (max. dia 1 mm) to solder a SOT on to a printed-circuit board.

Working method:

- Carefully unsolder one after the other the soldering tags of the semi-conductor
- Remove all superfluous soldering material. Use a sucking iron or sucking copper litze wire
- Check that the tags of the replacement part are clean and pre-tinned on the soldering places.
- Locate the replacement semi-conductor exactly on its place, and solder each tag to the relevant printed conductor on the circuit board.

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 deg C. The use of a solder with a low melting point is therefore recommended.

Take care not damage the plastic encapsulation of the SOT during the soldering procedure (softening point of the plastic is 150 ^{o}C).

ATTENTION: When you are soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

Suitable soldering irons are:

- ORYX micro-miniature soldering instrument, type 6A, voltage 6 V, in combination with PLATO pin-point tip type 0-569.
- ERSA miniature soldering iron, type minor 040 B, voltage 6 V.
- Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1 mm-pin-point tip, order no. 4822 395 10012.

3.3.11. Special tools

3.3.11.1. Special tool for the slotted nut of attenuator switches A and B, order no. 5322 395 54023

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.22. The material is silversteel N094, tempered 40-45 Rc.

3.3.11.2. Special tool for the slotted nut of the POSITION and LEVEL/SLOPE potentiometers, order no. 5322 395 54024

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.23. The material is silversteel N094, tempered 40-45 Rc.

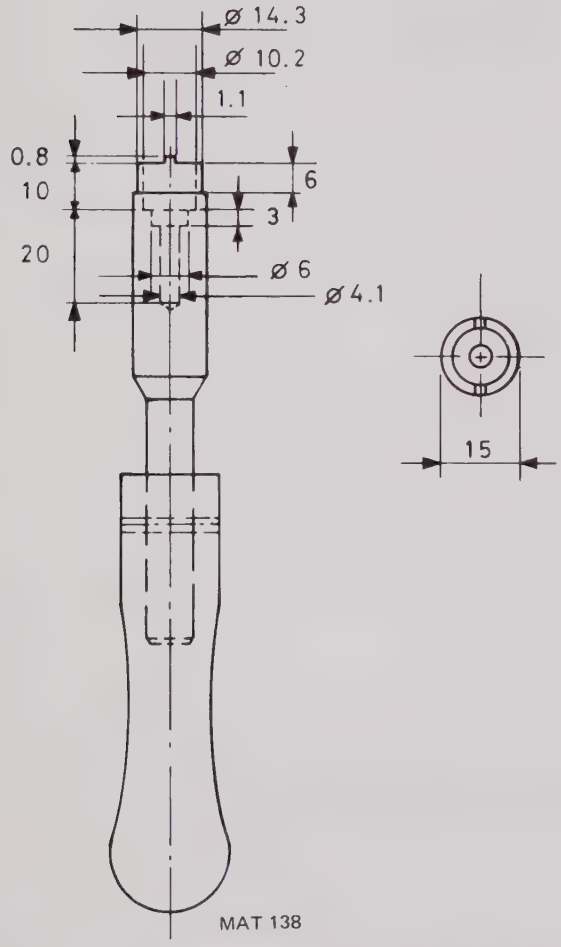

Fig. 3.22. Tool for attenuator unit

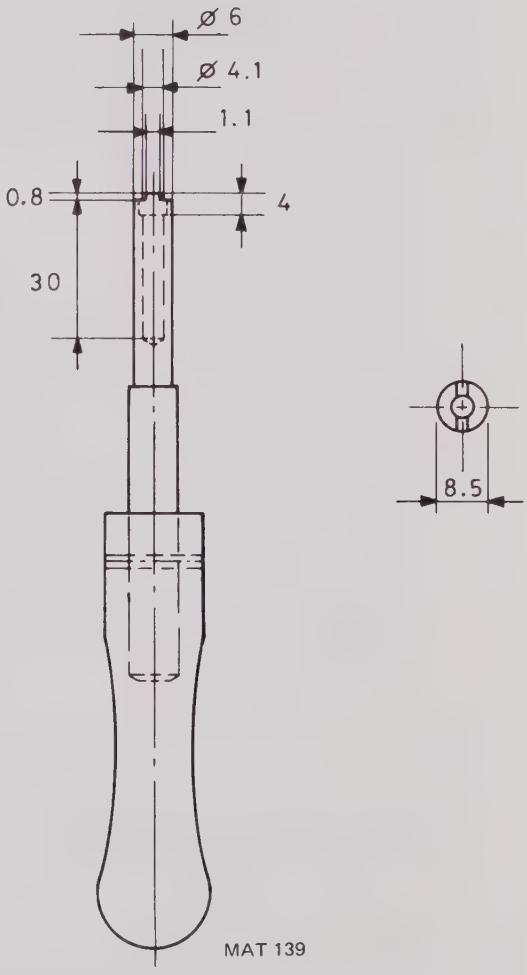

Fig. 3.23. Tool for positioning potentiometer

3.4. CHECKING AND ADJUSTING

3.4.1. General information

The following information provides the complete checking and adjusting procedure for the PM 3266 oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary. The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment.
Before any check or adjustment, the instrument must attain its normal operating temperature. Under average conditions this will be approximately 30 minutes after switching on.

All controls which are mentioned without item numbers are located on the front plate of the oscilloscope.

3.4.2. Recommended test equipment

Digital r.m.s. meter e.g. PHILIPS PM 2527.
Oscilloscope calibrator, e.g. TEKTRONIX TM503+SG503+TG501+PG506.
2:1 dummy probe (Fig. 3.27.), e.g. TEKTRONIX type 067.0537.00
Oscilloscope with differential input facility, e.g. PHILIPS PM 3240
Low capacitance trimming tools.

3.4.3 Preliminary control settings

All preset potentiometers and trimming capacitors are indicated on the drawings of the printed-wiring board, see the figures 3.31. and 3.32.

- Push the Y POSITION control to the NORM position.
- Depress push-buttons DC of the signal-coupling controls.
- Set the DELAY TIME control (R1) to 0 (fully anti-clockwise)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the TB MAGN control to position x1.
- Depress push-button AUTO of the trigger mode controls.
- Set the MAIN TIME/DIV switch to 1 ms
- Set the DEL'D TIME/DIV switch to OFF
- Set the TIME/DIV vernier controls to CAL.
- Depress push-buttons DC of the trigger-coupling controls
- Depress push-buttons A of the trigger-source controls (S21, S22).
- Except for the adjustment of the storage function (3.4.16.) the adjustments are carried out in the MEMORY OFF mode.

3.4.4. Power supply

3.4.4.1. Power consumption

- Check that the voltage has been set to the local mains voltage and connect the instrument to such a voltage.
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up.
- Check that the power consumption does not exceed 50 W (measured with a moving-iron meter).

3.4.4.2. +12,7 V supply voltage (Unit 5)

- Check at a mains voltage of 220 V that the voltage on the positive pole of C1831 is +12,7 V ± 100 mV; if necessary, readjust potentiometer R1826 on the power supply board.
- Check that this voltage does not vary more than ± 50 mV when the mains voltage is varied between 200 and 265 V.

Pre-set potentiometer R1827

This potentiometer is a factory adjustment control. THE SETTING OF THIS POTENTIOMETER MUST NOT BE DISTURBED UNLESS IT IS ABSOLUTELY IMPOSSIBLE TO SET THE 12.7 V WITH THE AID OF POTENTIOMETER R1826.

Adjusting procedure:

- Set the main input voltage to 220 V.
- Turn potentiometer R1827 fully anti-clockwise.
- Check that the voltage on the positive pole of C1831 is 12,7 V ± 100 mV; if necessary; readjust potentiometer R1826 on the power supply board.

- Set the mains input voltage to 170 V
- Check that the voltage on the positive pole of C1831 is +12,7 V ± 100 mV; if necessary, readjust potentiometer **R1827** on the power supply board.

3.4.4.3. Cathode voltage (unit 11)

- Check that the voltage on the collector of V2073 (unit 11) on the **Z amplifier board** is 85 V ± 3 V
- If necessary, readjust potentiometer **R2123** on the Z amplifier board.

3.4.5. Calibration socket

If necessary, check the supply voltages first, refer to section (3.4.4.).

- Check the calibration square wave on irregularities
- Check that the amplitude of the CAL voltage is 3 V ± 1 %; if necessary, readjust potentiometer **R1906** on the calibration board
- Check that the frequency of the CAL voltage is 2 kHz, ± 2 %
- Check that the CAL current is 6 mA ± 1 %.

3.4.6. Cathode-ray tube circuit

3.4.6.1. Focus and horizontal intensity.

- Check that the controls occupy the positions indicated in section 3.4.3.
- Depress pushbutton A of the vertical display mode selector (S1).
- Apply a sine-wave signal with the frequency of 100 kHz to input A.
- Adjust the trace height to 6 DIV, using the AMPL/DIV switch and vernier control.
- Set the MAIN TIME/DIV switch and the LEVEL control to such a position that several complete cycles are displayed.
- Set the INTENS control for normal brightness.
- Adjust trimming potentiometer R19 to optimal focusing in vertical direction. R19 can be reached via one of the ventilation holes in the left side of the instrument. The focusing in horizontal direction is adjustable by means of R17 on the front panel of the instrument.
- Increase the trace brightness by means of the INTENS control.
- Check if the trace stays well focused. If not readjust R19 somewhat.
- Remove the input signal.
- Adjust R2102 on the Z-amplifier unit to maximum equality of the trace in horizontal direction.

3.4.6.2. Trace rotation

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X-deflection controls (S2)
- Centre the time-base line using the POSITION controls
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines; if necessary, readjust the TRACE ROT control R15. This control can be reached via one of the ventilation holes on the left side of the instrument.

3.4.6.3. Orthogonality (unit 26)

- Depress push-button ALT of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button 0 of the channel A signal-coupling controls
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TB switch to 5 μs
- Set the channel B AMPL switch to 5 mV/DIV and its vernier control to CAL
- Apply a sine-wave voltage of 120 mV, frequency 100 kHz, to input B
- Centre the intensified part of the trace, using the DELAY TIME control (R1)
- Centre the channel A time-base line, using the channel A POSITION potentiometer
- Check that the angle between the horizontal and vertical line is 90°, see Fig. 3.24. If necessary, readjust **R1737** on the **X-amplifier unit.**

3.4.6.4. Geometry (= barrel and pin cushion distortion)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)

- Apply a sine-wave voltage at a frequency of approx. 100 kHz to input A
- Set the AMPL controls to obtain a trace height of 7,4 DIV
- Apply a sine-wave voltage at a frequency of approx. 50 Hz to input B
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button B of the main time-base trigger-source controls (S22)
- Set the channel B AMPL switch and X AMPL control to obtain a display width of 9,4 DIV.
- Check that the edges of the display lie within the hatched area shown in Fig. 3.25. ;if necessary, readjust potentiometer **R2103** on the **X-amplifier unit.**
- Remove the input signal.

3.4.6.5. Intensity (unit 11)

- Depress push-button A of the display-mode controls
- Depress push-button DEL'D TB of the X deflection controls
- Turn the INTENS potentiometer clockwise
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 μs
- Depress push-button 0 of the signal-coupling controls
- Depress push-button MAIN TB of the delayed time-base trigger-source controls
- Check that there is a barely visible dot at the beginning of the trace. If necessary, readjust potentiometer **R2064** on the **Z amplifier unit.**

3.4.6.6. Intensity ratio (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Turn the DELAY TIME control (R1) to 5.0 (mid-position)
- Set the MAIN TIME/DIV switch to .2 ms and the DEL'D TIME/DIV switch to 50 μs
- Depress push-button AC of the channel A signal-coupling controls
- Apply a sine-wave signal at a frequency of 100 kHz to input A
- Set the display-height to 6 DIV
- Set the INTENS potentiometer to a position 90^{o} from the anti clockwise stop; see Fig. 3.26.
- Check that the trace of the main time-base generator is barely visible over the entire screen and that the part determined by the delayed time-base generator is more brilliant. If necessary, readjust potentiometer **R1537** on the **time-base unit** .

3.4.7. Balance adjustments

The adjustments of the vertical channels A and B are identical.
The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.
The balance adjustments influence one another and must, therefore, be readjusted in the order in which they are described.

3.4.7.1. 0-DC Balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the channel A (B) AMPL switch to 5 mV/DIV and the vernier control to CAL.
- Centre the time-base line, using the POSITION potentiometers
- Set the channel A (B) signal coupling switch from 0 to DC
- Check that the trace does not jump; if necessary, readjust potentiometer R124 (Ch. A) or R174 (Ch. B) on the **attenuator board.**

3.4.7.2. Attenuator balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Depress push-button 0 of the channel A (B) signal-coupling controls
- Centre the time-base line, using the POSITION controls
- Turn the AMPL switch between 5 V/DIV and 10 mV/DIV
- Check that the trace does not jump more than 0,1 DIV; if necessary, readjust potentiometer R129 (Ch. A) or R179 (Ch. B) on the **attenuator board.**

3.4.7.3. Continue balance (Unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Depress push-button 0 of the channel A (B) signal-coupling controls
- Rotate the channel A (B) AMPL vernier control between minimum and maximum
- Check that the trace does not move more than 1 DIV in the 2 mV/DIV position, 0,4 DIV in the 5 mV/DIV position and 0,2 DIV in the other attenuator positions; if necessary, readjust potentiometer **R212 (R312)** on the **intermediate amplifier board.**

3.4.7.4. Balance 5 mV/div (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Depress push-button 0 of the channel A (B) signal-coupling controls
- Centre the time-base line, using the POSITION controls
- Check that the trace does not move more than 1 DIV when the AMPL switch is turned from 5 mV/DIV to 10 mV/DIV and not more than 0,1 DIV in the other positions except in the 2 mV/DIV position; if necessary, readjust potentiometer **R222 (R322)** on the **intermediate amplifier board.**

3.4.7.5. Polarity (Norm/Invert) balance (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Depress push-button 0 of the channel A (B) signal-coupling controls
- Centre the time-base line, using the POSITION controls
- Set the channel A (B) AMPL switch to 10 mV/DIV
- Check that the time-base line does not shift more than 0,3 DIV when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the intermediate amplifier board.
- Set the channel A (B) AMPL switch to 2 mV/DIV
- Check that the time-base line does not shift more than 2 DIV, see also section 1.2.2.13., when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the **intermediate amplifier board.**

3.4.7.6. Trigger balance main time-base (unit 16, unit 12)

- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button HF of the m.t.b. trigger-coupling controls (S20)
- Centre the time-base line using the m.t.b. LEVEL potentiometer
- Depress push-button DC of the m.t.b. trigger-coupling controls (S20)
- Check that the time-base line remains in the screen centre; if necessary, readjust potentiometer **R729** on the trigger source board
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Check that the time-base line remains in the screen centre; if necessary, readjust potentiometer **R426** on the **intermediate amplifier board**
- Depress push-button B of the m.t.b. trigger-source controls (S22)
- Check that the trace remains in the screen centre; if necessary, readjust potentiometer **R476** on the **intermediate amplifier board**
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave signal of 30 mV, frequency 2 kHz, to the m.t.b. EXT input
- Adjust the m.t.b. LEVEL potentiometer for a triggered display
- Check that the trace is written across the centre of the screen; if necessary, readjust potentiometer **R527** on the **intermediate amplifier board**
- Remove the input signal.

3.4.7.7. Trigger balance delayed time-base (unit 12)

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the MAIN TIME/DIV switch to .5 μs and its vernier to CAL
- Set the DEL'D TIME/DIV switch to .2 μs and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button A of the d.t.b. trigger-source controls (S21)

- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input A
- Centre the display, using the channel A POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL potentiometer.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer **R422** on the intermediate amplifier board.
- Depress push-button B of the display-mode controls (S1)
- Set the channel B AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button B of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input B
- Centre the display, using the channel B POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL control.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer **R472** on the **intermediate amplifier board**
- Remove the input signal.

3.4.7.8. Y Position correction (unit 13)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the vertical POSITION potentiometer to mid-position
- Short-circuit the input of the delay line on the intermediate amplifier board
- Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust potentiometer **R658** on the **final Y amplifier board.**

3.4.7.9. TB MAGN balance (unit 8)[1]

- Depress push-button MAIN TB of the X deflection controls (S2)
- Move the starting point of the time-base line to the centre of the screen, using the X POSITION control
- Check that the starting point does not move when the TB MAGN control is operated; if necessary, readjust potentiometer **R1749** on the **time-base board.**

3.4.8. Time-base generators

3.4.8.1. Main time-base time coefficients (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Set the d.t.b. TIME/DIV switch to OFF and its vernier to CAL
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL
- Depress push-button DC of the channel A signal-coupling controls
- Apply a time-marker signal of 600 mV, pulse repetition rate 1 ms, to the channel A input
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Check that the pilot lamps x10 and time-base UNCAL are off
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1709** on the time-base board
- Set the m.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R913** on the time-base board
- Set the m.t.b. TIME/DIV switch to 1 μs
- Change the repetition rate of the input signal to 1 μs.
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R911** on the time-base board.

- Pull the TB MAGN switch to x10
- Check that the x10 pilot lamp lights up
- Change the repetition rate of the input voltage to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1706** on the time-base board
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C916** on the time-base board
- Check that the other positions of the m.t.b. TIME/DIV switch, using the appropriate input signals; tolerance ± 2 % at an ambient temperature of 20 to +30 °C.
- Check that the control range of the m.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.

3.4.8.2. Delayed time-base time coefficients (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Rotate the DELAY TIME control (R1) fully anti-clockwise (minimum delay time)
- Push the TB MAGN switch to x1
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Check that the time-base UNCAL lamp is off
- Apply a time-marker signal of 600 mV, repetition rate 1 ms, to the channel A input
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL
- Adjust the d.t.b. LEVEL control for a stationnary display
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1326** on the time-base board
- Set the m.t.b. TIME/DIV switch to 10 ms
- Set the d.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1318** on the time-base board
- Set the m.t.b. TIME/DIV switch to 2 μs
- Set the d.t.b. TIME/DIV switch to 1 μs
- Change the repetition rate of the input signal to 1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1321** on the time-base board
- Set the m.t.b. TIME/DIV switch to .2 μs
- Set the d.t.b. TIME/DIV switch to .1 μs
- Change the repetition rate of the input signal to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C1311** on the time-base board
- Check the sweep times in all other positions of the d.t.b. TIME/DIV switch; tolerance ± 2% in temperature range +20 ... +30 °C. Keep during this check the DELAY TIME control fully anti-clockwise and the m.t.b. TIME/DIV switch one position slower than the d.t.b. TIME/DIV switch.
- Check that the control range of the d.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.

3.4.8.3. Delay time (unit 9)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DC of the channel A signal-coupling controls
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the d.t.b. trigger-source controls (S21)
- Push the TB MAGN switch to position x1

- Set the m.t.b. TIME/DIV switch to .1 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to .05 μs and its vernier to CAL
- Set the DELAY TIME control (R1) to 1.00
- Apply a time marker voltage with a repetition rate of .1 ms to the channel A input
- Check that the intensified spot on the trace coincides with the starting point of the second time marker pulse; if necessary, readjust potentiometer **R1384** on the trigger amplifier board
- Set the DELAY TIME control (R1) to 9.00
- Check that the intensified spot on the trace coincides with the starting point of the tenth time marker pulse; if necessary, readjust potentiometer **R1379** on the **trigger amplifier board**
- Remove the input signal.

As both adjustments are slightly interdependent, they must be repeated until both conditions are fulfilled.

3.4.8.4. Alternate time-base and trace separation

- Depress push-button A of the display-mode controls (S1)
- Depress push-button ALT TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .5 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to .5 μs and its vernier to CAL
- Depress push-button 0 of the channel A signal-coupling controls
- Check that the distance between the two traces is 0 DIV with the TRACE SEP control turned anti-clockwise and approximately 4 DIV with this control turned clockwise.

3.4.9. Sensitivities

Before checking the sensitivities, check the balances in accordance with section 3.4.7. Balance adjustments.

3.4.9.1. Gain (sensitivity) Y_A VIA X

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button AC of the channel A signal-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5 V/DIV and its vernier to CAL
- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel A input.
- Check that the trace width is 6 DIV; if necessary, readjust GAIN potentiometer R12 on the front panel.

3.4.9.2. Gain (sensitivity) Y_A VIA Y (unit 13)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button AC of the channel A signal-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5 V/DIV and its vernier to CAL
- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel A input.
- Check that the trace-height is 6 DIV; if necessary, readjust potentiometer **R654** on the **final Y amplifier board**
- Check that the control range of the channel A vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of the CAL position

3.4.9.3. Gain (sensitivity) Y_B VIA Y

- Depress push-button B of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button AC of the channel B signal-coupling controls
- Depress push-button B of the m.t.b. trigger-course controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5 V/DIV and its vernier to CAL

- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel B input
- Check that the trace height is 6 DIV; if necessary, readjust GAIN potentiometer R13 on the front panel
- Check that the control range of the channel B AMPL vernier control is 1:2,6 to 1:3,5 and the pilot lamp UNCAL lights up as soon as the vernier is out of the CAL position
- Remove the input signal

3.4.9.4. Gain (sensitivity) at external X deflection (unit 16)

- Depress push-button EXT $\overline{X}$ DEFL of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the X AMPL-HOLD OFF control to CAL
- Apply a 300 mV square-wave voltage, frequency 2 kHz, to the m.t.b. EXT input
- Check that the trace width is 6 DIV; if necessary, readjust potentiometer **R742** on the **trigger-source board**
- Check that the control range of the X AMPL-HOLD OFF control is 1:2,6 to 1:3,5
- Set the X AMPL-HOLD OFF control to CAL
- Depress push-button EXT ÷ 10 (S22) of the m.t.b. trigger-source controls
- Increase the amplitude of the input signal by a factor of 10
- Check that the trace width is 6 DIV ± 2 SUBDIV
- Remove the input signal

3.4.9.5. Gain (sensitivity) external triggering via TRIG VIEW (unit 9)

- Depress push-button TRIG VIEW of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a 600 mV square-wave voltage, frequency 2 kHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV; if necessary, readjust potentiometer **R852** on the **trigger-amplifier board**
- Remove the input signal.

3.4.9.6. Gain (sensitivity) Y_A TRIG VIEW

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel A AMPL switch to .5 V/DIV and its vernier to CAL
- Depress push-button A (S22) of the m.t.b. trigger-source controls
- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel A input
- Centre the display, using the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV ± 3 SUBDIV

3.4.9.7. Gain (sensitivity) Y_B TRIG VIEW

- Depress push-button TRIG VIEW of the display-mode controls (S1).
- Set the channel B AMPL switch to 0.5 V/DIV and its vernier to CAL
- Depress push-button B (S22) of the m.t.b. trigger-source controls.
- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel B input.
- Centre the display, using the m.t.b. LEVEL control R7.
- Check that the trace height is 6 DIV ± 3 SUBDIV

3.4.9.8. Gain (sensitivity) Y_B VIA X

- Depress push-button A of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button AC of the channel B signal-coupling controls
- Depress push-button B S22 of the m.t.b. trigger-source controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5 V/DIV and its vernier to CAL
- Apply a 3 V square-wave voltage, frequency 2 kHz, to the channel B input
- Check that the trace width is 6 DIV ± 1 SUBDIV
- Remove the input signal.

3.4.10. Vertical channels

The adjustments of the vertical channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A. Before performing the following tests, the balances and sensitivities must be checked in accordance with sections 3.4.7. and 3.4.9.

3.4.10.1. L.F. correction amplifier (Attenuator unit)

- Depress push-button A (B) of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Depress push-button DC of the channel A (B) signal-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the channel A (B) AMPL switch to 10 mV/DIV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to .2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, repetition rate 200 Hz, to the channel A (B) input
- Check that the pulse top is straight; if necessary, readjust potentiometer R132 (ch. A) or R182 (ch. A) on the attenuator board.

3.4.10.2. Square-wave response (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Depress push-button DC of the channel A (B) signal-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2 kHz, rise time ⩽ 200 ns, to the channel A (B) input; peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed +/– 3%; if necessary, readjust the relevant trimmers

A (B) AMPL	Y_A (Y_B) input signal	Adjuster	Trace height
2 mV	12 mV	–	6 DIV +/–3 %
5 mV	30 mV	–	6 DIV +/–3 %
10 mV	60 mV	–	6 DIV +/–3 %
20 mV	120 mV	–	6 DIV +/–3 %
50 mV	300 mV	–	6 DIV +/–3 %
.1 V	600 mV	C107 (ch. A) or C157 (ch. B)	6 DIV +/–3 %
.2 V	1,2 V	–	6 DIV +/–3 %
.5 V	3 V	–	6 DIV +/–3 %
1 V	6 V	C112 (ch. A) or C162 (ch. B)	6 DIV +/–3 %
2 V	12 V	–	6 DIV +/–3 %
5 V	30 V	–	6 DIV +/–3 %

- Remove the input signal.

3.4.10.3. Input capacitance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Depress push-button DC of the channel A (B) signal-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2 kHz, rise time ⩽200 ns, to the channel A (B) input via an 2:1 dummy probe, Fig. 3.27.
  (1 Mohm ± 0,1 %//15 pF); peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed +/–3 %; if necessary, readjust the relevant trimmers.

A (B) AMPL	Y_A (Y_B) input signal	Adjuster	Trace height
2 mV	12 mV	C101 (ch. A) or C151 (ch. B)	3 DIV +/–3 %
5 mV	30 mV	–	3 DIV +/–3 %
10 mV	60 mV	–	3 DIV +/–3 %
20 mV	120 mV	–	3 DIV +/–3 %
50 mV	300 mV	–	3 DIV +/–3 %
100 mV	600 mV	C104 (ch. A) or C154 (ch. B)	3 DIV +/–3 %
.2 V	1,2 V	–	3 DIV +/–3 %
.5 V	3 V	–	3 DIV +/–3 %
1 V	6 V	C109 (ch. A) or C159 (ch. B)	3 DIV +/–3 %
2 V	12 V	–	3 DIV +/–3 %
5 V	30 V	–	3 DIV +/–3 %

– Remove the input signal.

3.4.10.4. Square-wave response final Y amplifier

– Depress push-button ALT of the display-mode controls (S1)
– Depress push-buttons A and B (COMP) of the m.t.b. trigger-source controls (S22)
– Depress push-button MTB of the X deflection controls (S2)
– Set the Y POSITION controls to obtain a distance of 6 DIV between both time-base lines (channel A time-base line at the top)
– Set the X Masnifier in the x1 position
– Remove the main time-base connector from the alternate control pulse socket on the intermediate amplifier board, unit 12, socket 9, Fig. 3.24.
– Connect a square-wave generator to socket 9, Fig. 3.24.
– Set the output voltage of the generator to 3 V
– Both time-base lines will be displayed at a frequency determined by the frequency of the square-wave voltage.

200 Hz (unit 13)

– Set the generator frequency to 200 Hz
– Set the m.t.b. controls to obtain a suitable, triggered display
– Check that the top of the displayed pulse in straight within 2%; if necessary, put R634 in its mid position and select C613 to such a value that the square wave response is optimal.
– Adjust R634 to optimal square wave response.

2 kHz (unit 13)

– Set the generator frequency to 2 kHz
– Set the m.t.b. controls to obtain a suitable, triggered display
– Check that the top of the displayed pulse is straight within 2%; if necessary, put R636 in its mid position and select C614 to such a value that the square wave response is optimal.
– Adjust R636 to optimal square wave response.
– Reconnect socket 9 (Fig. 3.24.).

3.4.10.5. Square-wave response channel A (unit 12)

– Depress push-button A of the display-mode controls (S1)
– Push the Y POSITION controls to the NORM position
– Depress push-button DC of the channel A signal-coupling controls
– Set the channel A AMPL switch to 10 mV/DIV and its vernier to CAL
– Set the XMagnifier in the X1 position
– Depress push-button MTB of the Xdeflection controls (S2)
– Depress push-button A of the m.t.b. trigger-source controls (S22)
– Set the m.t.b. TIME/DIV switch to a suitable value
– Set the d.t.b. TIME/DIV switch to OFF
– Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to the channel A input
– Determine (for example with the use of an auxiliary potentiometer) the value for R256 that gives the best square wave response. A resistor with the selected value (between 1k6 and 4k7) must be soldered on the unit.
– Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary readjust potentiometer R255A or select a different value for capacitor C224 on the intermediate Y amplifier adjusting board
– Increase the repetition rate of the input signal to 30 kHz
– Put the instrument in the Magnifier X10 mode for better waveform analysis

- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R253A and R254A or select a different value for capacitors C222 and C223 on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse is straight within 2% and that the rise time is as short as possible, if necessary, readjust trimmers C221 on the intermediate Y amplifier board
- Select C200 on the intermediate amplifier (unit 12) to such a value (between 3p3 and 6p8) that the square wave response is optimal
- Set the generator frequency to 30 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary , readjust trimmer C616 on the final Y amplifier board
- Set the generator frequency to 100 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary, select a different value for resistor R646 on the final Y amplifier board
- Check the square-wave response in positions 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel A Y POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button O of the channel A signal-coupling controls
- Depress push-button ADD of the display-mode controls and check that the response does not change
- Check that the pulse top aberrations remain within ±2%
- Remove the input signal

3.4.10.6. Square-wave response channel B *(unit 12)*

- Depress push-button B of the display-mode controls (S1)
- Push the channel A POSITION control to NORM position
- Depress push-button DC of the channel B signal-coupling controls
- Set the channel B AMPL switch to 10 m V/DIV and its vernier to CAL
- Set the XMagnifier in the X1 position
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button B of the m.t.b. trigger source-controls (22)
- Set the m.t.b. TIME/DIV switch to a suitable value
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to channel B input
- Determine (for example with the use of an auxililiary potentiometer) the value for R356 that gives the best square wave response. A resistor with the selected value (between 1k6 and 4k7) must be soldered on the unit
- Check that the pulse top is straight within 2% and the rise time is as short as possible; if necessary readjust potentiometer R255B or select a different value for capacitor C324 on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 30 kHz
- Put the instrument in the Magn X10 mode for better waveform analysis
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R253B and R254B or select a different value for capacitors C322 and C323 on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust trimmers C321 (this one also affects channel A) on the intermediate amplifier board
- Select C300 on the intermediate amplifier (unit 12) to such a value (between 3p3 and 6p8) that the square wave response is optimal
- Check the square-wave response in position 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel B POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button O of the channel B input-coupling controls
- Depress push-button ADD of the display-mode and check that the response does not change
- Check that the pulse top aberrations remain within ± 2%
- Remove the input signal

3.4.10.7. Bandwidth

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to the NORM position
- Set the channel A (B) AMPL switch to 2 mV/DIV and its vernier to CAL
- Depress push-buttons AC of the signal coupling controls
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUT of the trigger-mode controls
- Depress push-button HF of the trigger-coupling controls
- Depress push-button A (B) of the trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 16 mV_{p-p}, frequency 2 MHz , to the channel A (B) input
- Check that the trace height is 8 DIV
- Increase the frequency of the input signal to 35 MHz
- Check that the trace height is at least 5,6 DIV
- Set the channel A (B) AMPL switch to 5 mV/DIV and its vernier to CAL
- Increase the input voltage to 40 mV_{p-p}, frequency 2 MHz
- Check that the trace height is 8 DIV
- Increase the frequency of the input voltage to 100 MHz
- Check that the trace height is at least 5,6 DIV
- Remove the input signal

3.4.10.8. Common-mode rejection

- Depress push-button ADD of the display-mode controls (S1)
- Push the channel A POSITION control to NORM
- Push the channel B POSITION control to INVERT
- Set both AMPL controls to 10 mV/DIV and their verniers to CAL
- Apply a sine-wave voltage of 240 mV_{p-p} simultaneously to the channel A and B inputs
- Check the rejection in accordance with the following table

Note: Adjust the channel A or B AMPL vernier control for minimum trace height.

Input voltage	Frequency	Max. trace height	Rejection factor
240 mV	100 kHz	1,2 SUBDIV	>100
240 mV	2 MHz	1,2 SUBDIV	> 100
240 mV	50 MHz	6 SUBDIV	> 20

- Remove the input signal.

3.4.10.9. Dynamic range and position range

- Depress push-button A of the display-mode controls (S1)
- Set both AMPL switches to 5 mV/DIV and their verniers to CAL
- Apply a sine-wave signal of 120 mV_{p-p}, frequency 10 kHz, to the channel A (B) input
- Check that the top and bottom parts of the sine-wave signal can be displayed, reasonably undistorted, within the measuring graticule, using the channel A (B) POSITON control
- Remove the input signal.

3.4.10.10. Chopped mode

- Depress push-button CHOP of the display-mode controls
- Set the m.t.b. TIME/DIV switch to .2 μs
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITON controls.

3.4.10.11. Alternate mode

- Depress push-button ALT of the display-mode controls
- Set the m.t.b. TIME/DIV switch to 10 μs
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITION controls
- Set the m.t.b. TIME/DIV switch to .1 s
- Check that the channels are switched over after every sweep of the time-base voltage.

3.4.10.12. Square-wave response trigger view via channel A (B) (Unit 12)

- Depress push-button TRIG VIEW of the display-mode controls
- Push the Y POSITION controls to the NORM position
- Depress push-button DC of the channel A and B signal-coupling controls
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Depress push-button MTB of the X deflection controls
- Depress push-button A (B) of the m.t.b. trigger-source controls
- Set the m.t.b. TIME/DIV switch to a suitable position
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, frequency 2 kHz, rise time 1 ns, to the channel A (B) input
- Check that the pulse top is straight and the rise time as short as possible
- Increase the repetition rate of the input signal to 30 kHz
- Check that the pulse top is straight within 5 % and that the rise time is as short as possible, if necessary, select a different value for resistors **R255D, R254D (R255C, R254C)** and capacitors **C400, C405 (C450 C455)** on the intermediate amplifier board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse top is straight within 5 % and that the rise time is as short as possible; if necessary, select a different value for resistor **R253D (R253C)** and capacitors **C410 (C460)** on the **intermediate amplifier board**
- Remove the input signal.

3.4.10.13. Bandwidth trigger view via channel A (B)

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Push the Y POSITION controls to NORM position
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Depress push-buttons AC of the signal-coupling controls
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button HF of the m.t.b. trigger-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 60 $mV_{p\text{-}p}$, frequency 2 MHz, to the channel A (B) input
- Check that the trace height is 6 DIV
- Increase the frequency of the input voltage to 50 MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal

3.4.10.14. Bandwidth trigger view via external input

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 600 $mV_{p\text{-}p}$, frequency 2 MHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV
- Increase the frequency of the input signal to 50 MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal.

3.4.11. Triggering

3.4.11.1. Trigger slope and level of the m.t.b. (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button DC of the channel A input-coupling controls
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 10 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION controls
- Centre the starting point of the sine-wave, using the m.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to –; if necessary, readjust potentiometer **R860** on the **trigger-amplifier board**
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going edge of the sine-wave and moves upwards when the LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to its – position
- Check that the time-base generator starts on the negative-going edge of the sine-wave.
- Set the channel A AMPL switch to 5 mV/DIV
- Rotate the m.t.b. LEVEL control fully clockwise and fully anti-clockwise
- Check that in both extreme positions the time-base generator cuts out and that the NOT TRIG'D lamp lights up
- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the m.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered and that the NOT TRIG'D lamp does not light up
- Remove the input signal.

3.4.11.2. Trigger sensitivities m.t.b.

- Depress push-button MTB of the X deflection controls (S2)
- Adjust the m.t.b. LEVEL control for a stationary display
- Depress push-buttons DC of the signal-coupling controls
- Set the m.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written on the screen
- Set the d.t.b. TIME/DIV switch to OFF
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger mode	Trigger coupling	Trigger source	Trace height/ Volts
A	20 Hz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	20 Hz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
B	20 Hz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
EXT	20 Hz	A	TRIG	DC	EXT	50 mV up to 150 mV
EXT	20 kHz	A	TRIG	DC	EXT	50 mV up to 150 mV
EXT	100 MHz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and B	20 kHz	ALT	TRIG	DC	A+B	

- Remove the input signal

3.4.11.3. Single-sweep operation

- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to .2 V/DIV and its vernier to CAL
- Depress push-button MTB of the X deflection controls (S2)
- Set the m.t.b. LEVEL control to mid-range
- Set the m.t.b. TIME/DIV switch to .1 s and the vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button 0 of the channel A signal-coupling controls
- Apply a signal that gives a trace height of approx. 6 DIV to input A
- Push the SINGLE button of the m.t.b. trigger-mode controls
- Check that the NOT TRIG'D lamp lights up
- Depress push-button AC of the channel A signal-coupling controls
- Check that the trace is written once and that the NOT TRIG'D lamp is extinghuished at the end of the sweep
- Remove the input signal.

3.4.11.4. Triggering at mains frequency

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button DC of the trigger-coupling controls
- Set the m.t.b. TIME/DIV switch to 5 ms and its vernier to CAL
- Depress push-button EXT of the trigger-source controls (S22)
- Apply a mains voltage derived signal to the channel A input
- Adjust the trace height to approx. 3 DIV; the trace must be running
- Depress push-button EXT and EXT ÷ 10 (S22) simultaneously (LINE)
- Check that a stable display can be obtained, using the m.t.b. LEVEL control
- Remove the input signal.

3.4.11.5. Trigger slope and level of the d.t.b.

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Turn the DELAY TIME (R1) control fully anti-clockwise
- Set the m.t.b. TIME/DIV switch to 20 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 10 μs and its vernier to CAL
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION controls
- Centre the starting point of the sine-wave, using the d.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to –
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going part of the sine-wave and moves upwards when the d.t.b. LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to – position
- Check that the time-base generator starts on the negative-going part of the sine-wave
- Set the channel A AMPL switch to 5 mV/DIV and its vernier to CAL
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the time-base generator cuts out
- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered.

3.4.11.6. Trigger sensitivities d.t.b.

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Adjust the d.t.b. LEVEL control for a stationary display
- Depress push-button AUTO of the m.t.b. trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-buttons DC of the signal-coupling controls of the m.t.b.
- Set the m.t.b. TIME/DIV switch one position lower (longer sweep time) than the d.t.b. TIME/DIV switch
- Set the d.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written (not for 20 Hz)
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger coupling d.t.b.	Trigger source d.t.b.	Trace height Volts
A	20 Hz	A	DC	MAIN TB	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	MAIN TB	0,5 DIV up to 1,5 DIV
A	20 Hz	A	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	A	0,5 DIV up to 1,5 DIV
A	20 Hz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	HF	A	0,5 DIV up to 1,5 DIV
B	20 Hz	B	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	DC	B	0,5 DIV up to 1,5 DIV
EXT dtb	20 Hz	B	DC	EXT	50 mV up to 150 mV
EXT dtb	20 kHz	B	DC	EXT	50 mV up to 150 mV
EXT dtb	100 MHz	B	DC	EXT	50 mV up to 150 mV

- Remove the input signal.

3.4.12. Jitter

- Depress push-button A of the display-mode controls (S1)
- Set the DELAY TIME (R1) control to 9.00
- Push the TB MAGN switch to position x1
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the d.t.b. TIME/DIV switch to 1 μs and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Depress push-button AUTO of trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the d.t.b. trigger-source controls (S21)
- Apply a square-wave voltage for a trace height of 4 DIV, repetition rate 20 μs, to the channel A input
- Adjust the m.t.b. LEVEL control for a stable, triggered display
- Check that the time jitter does not exceed 0,3 DIV
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Check that a jitter-free display can be obtained, setting the d.t.b. LEVEL control
- Remove the input signal.

3.4.13. Periodic and random deviations

These must be measured only with the cabinet plates fitted

- Inputs of channels A and B open
- Depress push-buttons AC of the signal-coupling controls
- Set both AMPL switches to 2 mV/DIV and their verniers to CAL
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUT of the trigger-mode controls
- Measure the periodic and random deviations in accordance with the following table:

Ripple	¼ SUBDIV at maximum
Noise	¼ SUBDIV at maximum
Microscopy	¼ SUBDIV at maximum
Converter interference	¼ SUBDIV at maximum
Instability of the trace	¼ SUBDIV at maximum

Parasitic Z modulation must not be visible

3.4.14. Effect of the mains voltage variations

- Depress push-button CHOP of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Pull the TB MAGN switch to x10
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button AUTO of the trigger-mode controls
- Set both AMPL switches to 0.5 V/DIV and their verniers to CAL
- Depress push-buttons AC of the signal-coupling controls
- Interconnect the CAL socket and inputs A and B
- Vary the mains voltage by.+ and − 10 %
- Check that neither trace height nor trace width changes and that the briliance remains the same

3.4.15. Horizontal amplifier

3.4.15.1. Bandwidth

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 3 $V_{p\text{-}p}$, frequency 2 kHz, to the channel A input
- Check that the trace width is 6 DIV
- Increase the frequency of the input signal to 2 MHz
- Check that the trace width is at least 4,2 DIV

3.4.15.2. Phase difference

- Depress push-button CHOP of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set both AMPL switches to 5 mV/DIV and their verniers to CAL
- Depress push-buttons DC of the signal-coupling controls
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 30 $mV_{p\text{-}p}$, frequency 100 kHz, to both input A and B
- Check that the phase difference does not exceed 3 ^{o} (see Fig. 3.28.) in which $\frac{B}{A}$ equals the sine of the phase error angle.

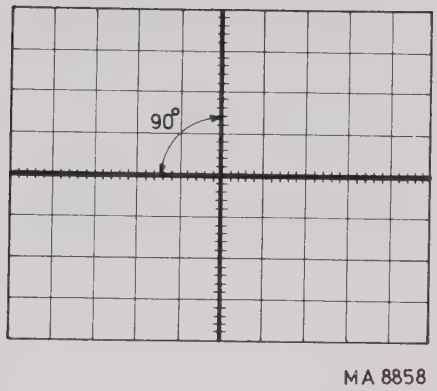

Fig. 3.24. Orthogonality check

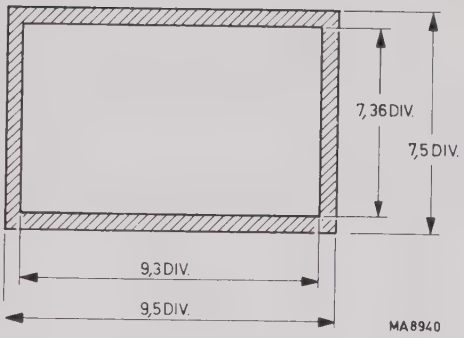

Fig. 3.25. Geometry check

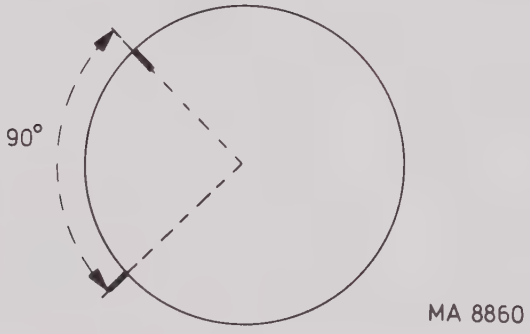

Fig. 3.26. Position of the INTENS potentiometer

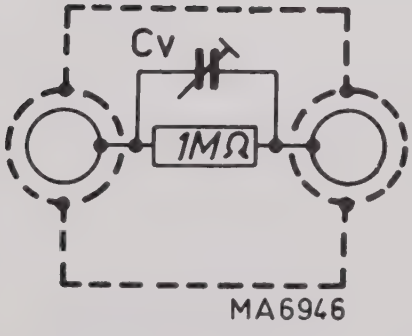

Fig. 2.27. 2:1 Dummy probe

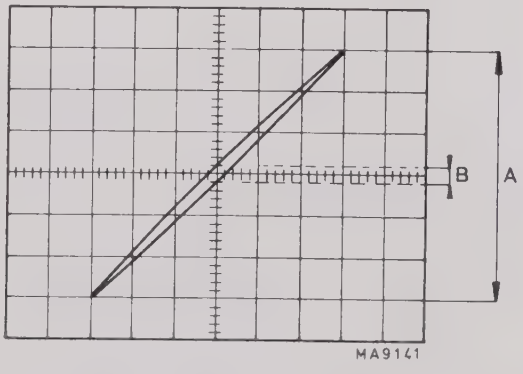

Fig. 3.28. Phase difference in X-Y mode

	NON STORE MODE	VARIABLE PERSISTENCE MODE (ERASE PULSES)
VOLTAGE ON ↓		TIME INTERVALS (MS): 0 | 100 | 500 (1) | 300 (2) | 300 (3) | 300 (4) | >300 (5)
FLOOD GUN CATHODE	0V	0V
FLOOD GUN ANODE	20V	20V / 50V
COLLIMATOR 1	30V	30V / 90V
COLLIMATOR 2	V6	V6 — R2523
COLLIMATOR 3	75V	75V / V7 / V8 — R2404
COLLECTOR MESH G10	150V	150V
FAST MESH G11	140V	140V
FRONT MESH G12	−35V	500V; R2577 — V1; R2427 — V2; in MAX R2414; DYNAMIC ERASE PULSES 100Hz DUTY CYCLE: 0....30%; R2423

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Fig. 3.29. Adjustments of the VARIABLE PERSISTENCE and STORE MODE

3.4.16. Adjustment of storage section

3.4.16.1. INTRODUCTION

The voltage levels that must be adjusted are indicated V1 till V8. These voltage levels are indicated in Fig. 3.29. for the NON STORE and VARIABLE PERSISTENCE modes and in Fig. 3.30. for the FAST mode.
The voltage levels can be measured with an oscilloscope: when measuring voltage levels on the front mesh take care that the measuring oscilloscope and attenuator probe can withstand the 500 Volt pulses.

3.4.16.2. NON STORE MODE (MEMORY OFF)

The Collimator 2 voltage V6 must be adjusted in the VARIABLE PERSISTENCE mode.

3.4.16.3. VARIABLE PERSISTENCE MODE

1. Turn the PERSISTENCE control (R16) fully counter clockwise so that the dynamic erase pulses on the front mesh are switched on. Adjust these pulses to approx. +8 Volt by means of R2423.

   Adjust the storage level V1 on the front mesh to 0 Volt by means of R2577.
   Adjust the erase pulse voltage V2 on the front mesh to +10 Volt by means of R2427.
2. Adjust the voltage on collimator 2 to the lowest possible value by means of R2523.
   The borders of the illuminated area on the CRT screen must be just invisible.
3. Turn the PERSISTENCE control (R16) to its first clockwise stop (not in the MAX position) so that the dynamic erase pulses on the front mesh are switched off.
   Depress the ERASE pushbutton (S25) and decrease by means of R2427 the erase pulse voltage V2 so that the CRT screen is just black. Repeat this procedure in order to obtain optimum result.
4. In the MAX WRITE position the storage level is increased a little and the background illumination on the CRT screen can be adjusted to the desired value by means of R2414.
5. The illumination of the left half and the right half of the CRT screen must be equal. This must be adjusted by means of R2549. R2549 determines the cathode current of the left and the right flood gun system.
6. Adjust by means of R2404 the pulse voltage V7 on collimator 3 in such a way that the background illumination over the whole screen area is divided as equal as possible after the ERASE pushbutton has been depressed.

3.4.16.4. FAST MODE

Before starting this adjustment the writing gun must be adjusted well in the NON STORE mode.
The adjustment of the writing gun is alright if:

1. One cycle of a sine wave signal of 50 MHz and 6 divisions height can be written in.
2. The modulation pulse on G1 of the CRT during the writing in cycle is 80 Volt.
   When measuring this take care of dangerous voltages.
3. The defocusing in horizontal direction on the left half and the right half of the CRT screen is minimal and symmetrical.

The adjustable voltages must be adjusted as follows:

1. Adjust voltage level V2 on the front mesh by means of R2429 to +5 Volt.
   Adjust voltage level V3 on the front mesh by means of R2419 to 0 Volt.
   Adjust voltage level V4 on the fast mesh by means of R2408 to +2 Volt.
   Adjust voltage level V5 on the fast mesh by means of R2412 to +1 Volt.
2. Depress the ERASE pushbutton and check if the CRT screen is black if the instrument stands waiting for writing in a signal. If this is not the case, voltage level V3 on the front mesh must be decreased by R2419 till the screen is just black.
3. Depress the ERASE pushbutton and write one cycle of the 50 MHz/6 div. signal in.
   Voltage level V5 must be decreased by R2412 if after the transfer pulse the screen is illuminated with max. intensity or if parts of the written in signal are visible on a background with a too high intensity.
   Voltage level V5 must be increased if after the transfer pulse the background intensity is alright and the written in signal is hardly visible.

In other words: V5 must be adjusted to optimum writing speed and contrast. The performence can also be influenced a little with small changes in the setting of V2 (R2429) and V1 (R2577) of the front mesh.

4. Depress the ERASE pushbutton and write directly a signal in.
   Remember the recorded picture.
   Again depress the ERASE pushbutton and wait one minute with writing in the signal.
   Now compare the two pictures.
   Decrease the voltage levels V4 (R2408) and V5 (R2412) if the second picture has a higher intensity.
   Increase the voltage levels V4 (R2408) and V5 (R2412) if the second picture has a lower intensity.
   If the voltage levels V4 and V5 are increased the voltage difference must also increase.
   If the voltage levels V4 and V5 are decreased the voltage difference must also decrease.
   Repeat the adjusting procedure described above in order to obtain a stable functioning.
5. Adjust the pulse voltage V8 on the collimator 3 to an equable background intensity over the whole screen.
   Repetively erasure and adjustment is necessary to obtain an optimum result.

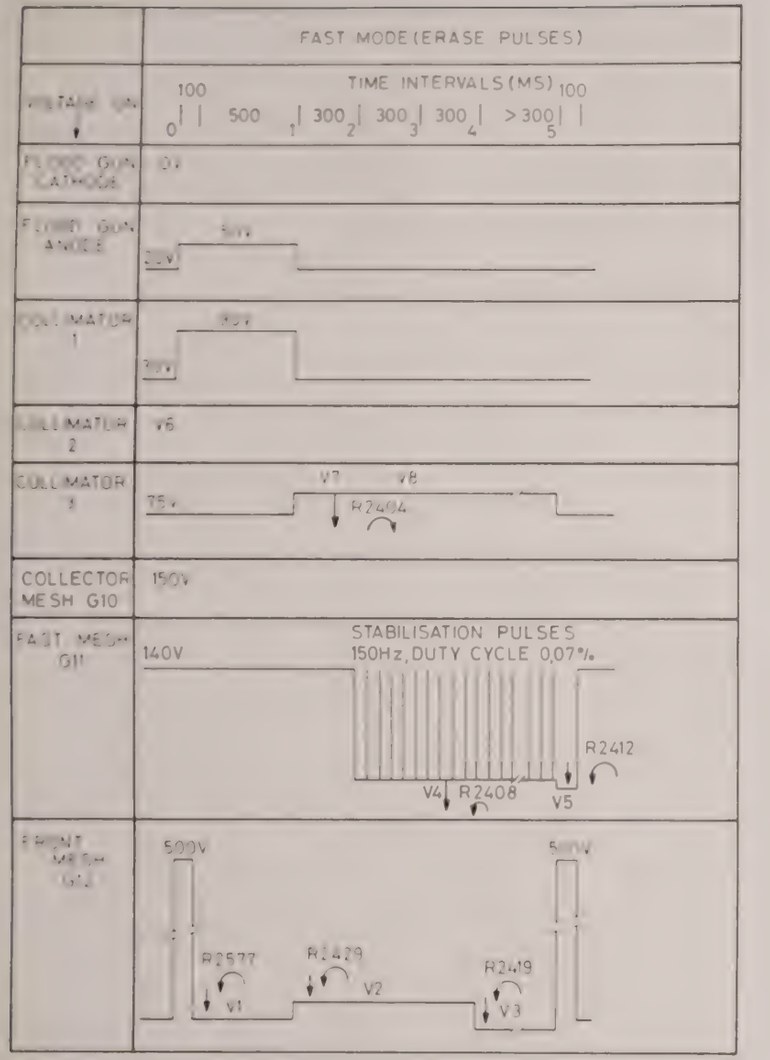

Fig. 3.30. Adjustment of voltage levels on CRT storage electrodes in FAST. mode

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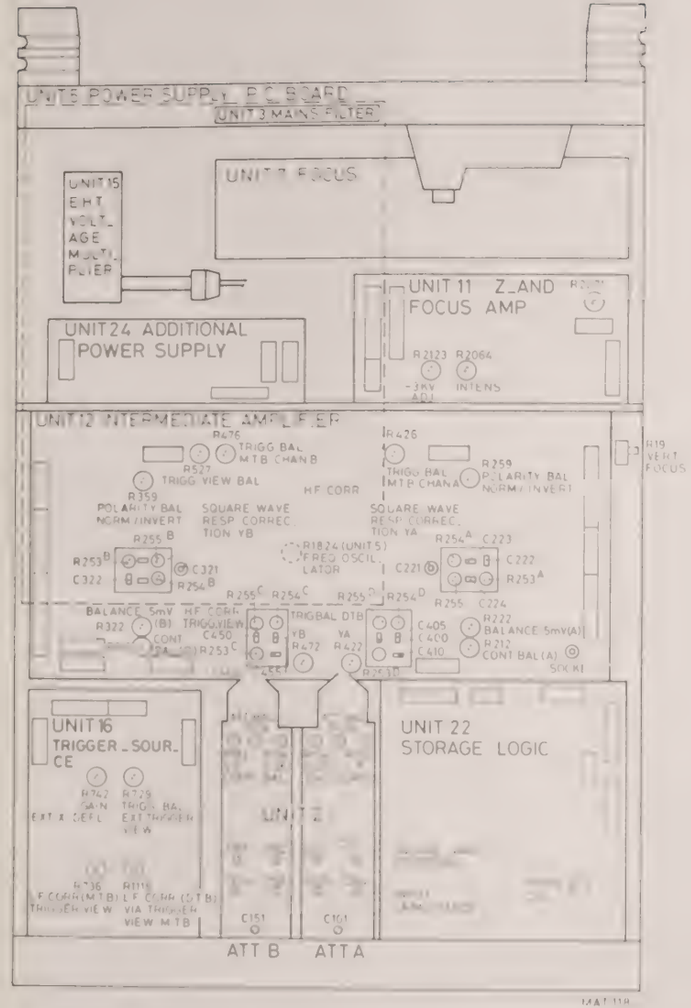


Fig. 3.31. Unit lay-out and Adjustment points (bottom view)

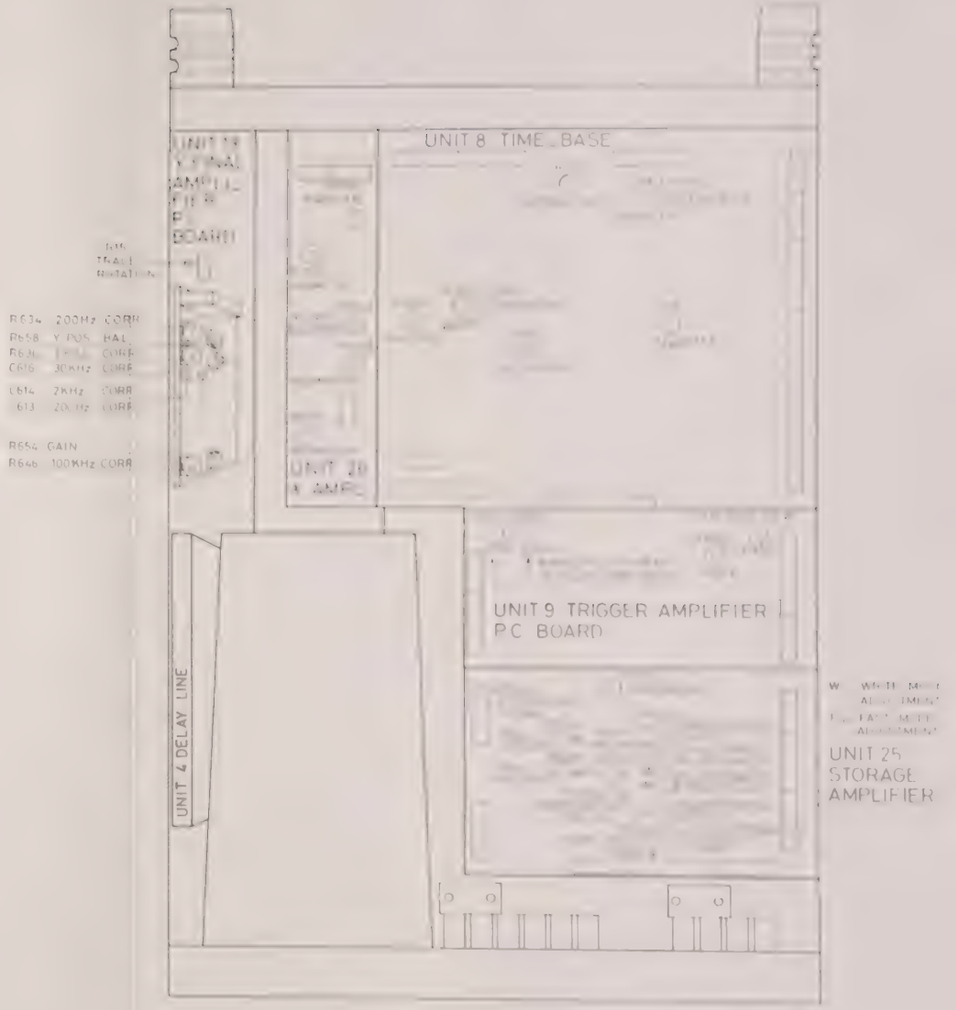


Fig. 3.32. Unit lay-out & adjustment points, top view

3.5. INFORMATION CONCERNING ACCESSORIES

3.5.1. Attenuator probe set delivered with the instrument

This 10x attenuator probe is designed for real time oscilloscopes up to 250 MHz, having a BNC input jack and 13 pF ± 3 pF input capacitance paralleled by 1 MΩ. The PM 8935L is a similar probe with a cable length of 2,5 metres.

3.5.1.1. Specifications

Electrical

Attenuation	10x ± 2 % (Oscilloscope input 1 MΩ ± 1 %)
Input resistance d.c.	10 MΩ ± 2 % (Oscilloscope input 1 MΩ ± 5 %)
a.c.	See curve Fig. 3.33.
Input capacitance d.c. and l.f.	11 pF ± 1 pF (Oscilloscope input 1 MΩ ± 5 % paralleled by 13 pF ± 3 pF)
Input resistance h.f.	See curve Fig. 3.33.
Bandwidth	Probe has negligible effect on oscilloscope bandwidth
Max. input voltage	500 V d.c. + a.c. $_{peak}$, derating with frequency. See Fig. 3.34. Oscilloscope input 1 MΩ and voltage applied between probe tip and earthed part of probe body. Test voltage 1500 $V_{d.c.}$ during 1 s, at a temperature between 15 and 25 °C, a rel. hum. of 80 % at maximum and at sea level.
Check zero button on probe shell	Same function as 0 position of input coupling switch on oscilloscope

Environmental

Probe operates within specifications over the following ranges:

Temperature	−25 °C to +70 °C
Altitude	Up to 5000 metres (15000 feet)
Other environmental data	Same as for the oscilloscope the probe is used with

Mechanical

Dimensions	Probe body 103 mm x 10 mm dia (max.) Cable length 1500 mm or 2500 mm Correction box 55x30x15 mm incl. BNC
Mass	Incl. standard accessories 125 g.

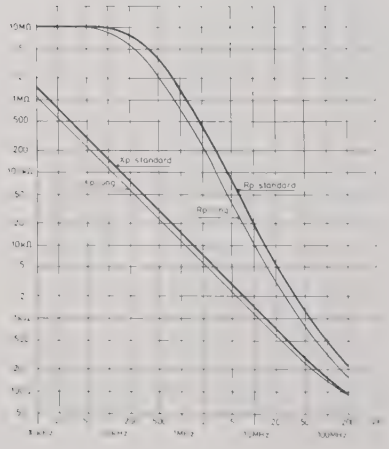


Fig. 3.33. Input restance (R_p) and reactance (X_p) versus frequency.

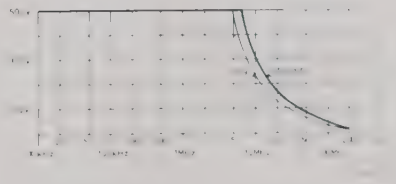
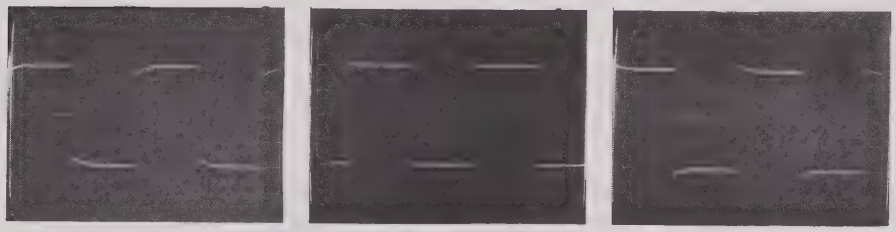


Fig. 3.34. Max AC component of input voltage as a function of frequency.

3.5.1.2. Adjustments

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to the CAL socket of the oscilloscope
A trimmer C2 can be adjusted through a hole in the compensation box to obtain optimum square-wave reponse. See Fig. 3.35.

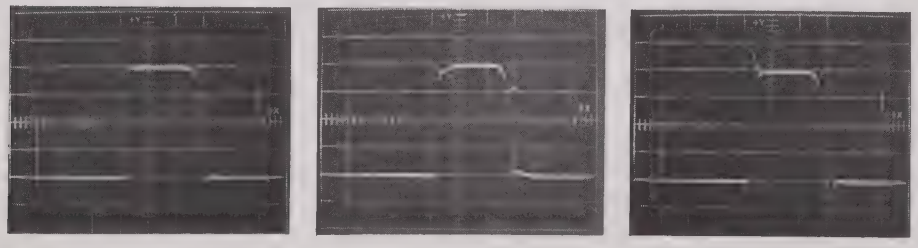


a b c

Fig. 3.35. Adjusting C2

Adjusting the h.f. step response

The h.f. step-response correction network has been adjusted by the manufacturer to match an average oscilloscope input. For optimum pulse response, however, the probe can be adjusted to match your particular oscilloscope. Later readjustment is only necessary if the probe is to be used with a different type of oscilloscope, or after replacement of an electrical component.
For the adjustment, proceed as follows.
Connect the probe to a fast pulse generator (rise time not exceeding 1 ns) which is terminated by its characteristic impedance. Dismantle the compensation box as described in section 3.5.1.3. Set the generator to 100 kHz. Adjust C3, C4, R2, R4 and R5 alternatively to obtain a display as shown in Fig. 3.36.a.
It is important that the leading edge is as steep, and the top is as flat, as possible. Incorrect settings of C3, C4 R2, R4 and R5 give rise to pulse distortions as shown in Fig. 3.36b and 3.36c.



a b c

Fig. 3.36. Adjusting the h.f. step response

3.5.1.3. Dismantling

Dismantling the probe (see Fig. 3.37.)

The front part 11 of the probe can be screwed from the rear part 13. Item 11 can then be slid from 12 and 13. The RC combination 12 is soldered to 13. For replacement of 12 refer to section 3.5.1.4.

Dismantling the compensation box (see Fig. 3.37.).

Unscrew the ribbed collar of the compensation box to the cable. The case 14 can then be slid of the compensation box sideways. The electrical components on the printed-wiring board are then accessible.

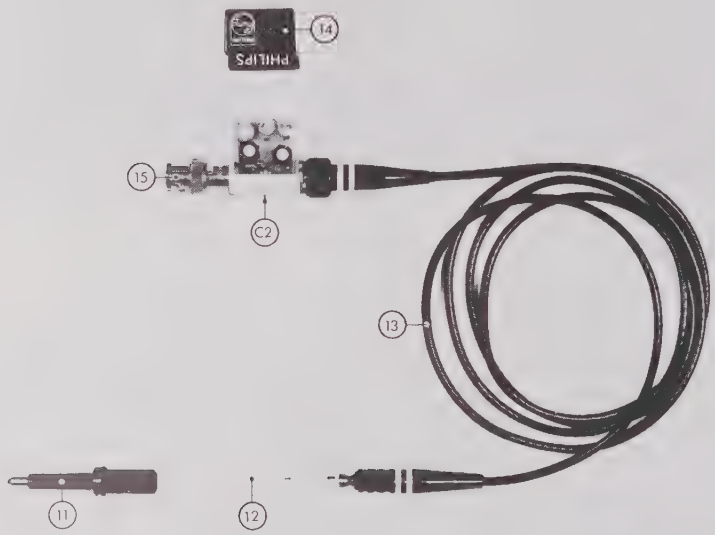


Fig. 3.37. Dismantling.

3.5.1.4. Replacing parts

Assembling the probe

A new RC network is slid over the cable nipple after which the cable core is soldered on to the resistor wire. When the measuring probe is assembled, the RC network must be at dead centre in the probe tip.

Replacing the cable assembly

Dismantle the compensation box as described in section 3.5.1.3.
Unsolder the connection between the inner conductor and the printed-wiring board. Keep the frame of the compensation box steady and loosen the cable nipple with a 5 mm spanner on the hexagonal part. Replace the cable and fit it working in the reverse order.

Replacing the BNC

Dismantle the compensation box as described in section 3.5.1.3
Unsolder the connection to the printed-wiring board. Keep the frame of the compensation box steady and loosen the BNC with a 3/8 inch spanner. Replace the BNC and fit it working in the reverse order.

Replacing the probe tip

The damaged tip can be pulled out by means of a pair of pliers. A new tip must be firmly pushed in.

3.5.1.5. Parts lists

3.5.1.5.1. Mechanical parts (see Fig. 3.37. and 3.38.).

Item	Order number	Qty	Description
1	5322 321 20223	1	Earth cable
2	5322 256 94136	1	Probe holder
3	5322 255 44026	5	Soldering terminals which may be incorporated in circuits as routine test points
4	5322 532 64223	2	Marking ring red
5	5322 532 64224	2	Marking ring white
	5322 532 64225	2	Marking ring blue (not shown)
6	5322 268 14017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	5322 462 44318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	5322 264 24018	1	Wrap pin adapter
10	5322 264 24019	1	Spring-loaded test clip
11	5322 264 24021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network PM 8935
	5322 216 54153	1	RC network PM 8935L
13	5322 320 14063	1	Cable assy PM 8935
	5322 320 14064	1	Cable assy PM 8935L
14	5322 447 64015	1	Cap
15	5322 268 44019	1	BNC connector

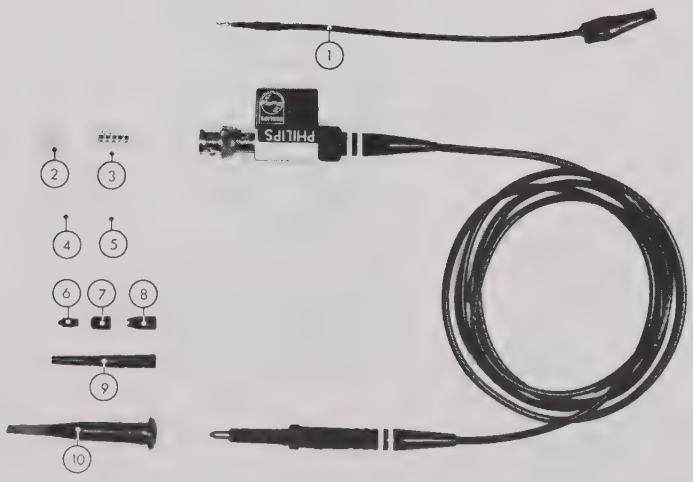


Fig. 3.38. Mechanical parts.

3.5.1.5.2. Electrical parts

Item	Order number	Description
C1	–	Part of RC network (not supplied separately)
C2	5322 125 54003	Trimmer 60 pF, 300 V
C3	5322 125 50048	Trimmer 3,5 pF, 300 V, PM 8935
C4	5322 125 50051	Trimmer 18 pF, 300 V
L1	–	Coil (not supplied)
R1	–	Part of RC network (not supplied separately)
R2	5322 100 10135	Potmeter 470 Ω, 20 %
R3	5322 116 50536	Metal film resistor 464 Ω, 1 %, MR25
R4	5322 100 10135	Potmeter 470 Ω, 20 %
R5	5322 100 10143	Potmeter 1 kΩ, 20 %

If a complete new probe is required, type PM 8935 must be ordered.

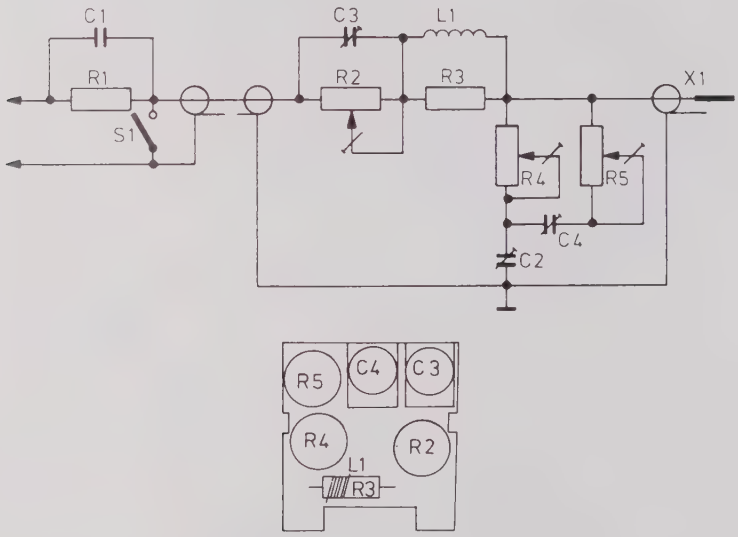


Fig. 3.39. Electrical parts.

3.5.2. Adapter PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm banana plugs.

Fig. 3.40. Adapter PM 9051

3.5.3. Trimming Tool Kit (Type 800/NTX)

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins.

The wide variety of pins allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).

Ordering number: 4822 310 50015
(A spare set containing the 8 most commonly used pins is available under the Ordering number: 4822 310 50016).

Fig. 3.41. Trimming tool kit

3.6. EXTRA IN- AND OUTPUTS

3.6.1. Introduction

The PM 3266 is equipped with a Z-MOD input mounted at the rear panel and with facilities to add two extra outputs with a minimum of components. The output sockets are mounted in the holes already present in the rear panel.

External Z-modulation input

Characteristics:

- DC coupled
- TTL compatible
- "Positive polarity" blanks display
- Response time 35 ns
- Input impedance 10 kΩ
- Max. input voltage 50 V.

3.6.2. **Main time-base gate output** (Optionally available)

Characteristics:

- Output voltage 0 ... +5 V delivered during MTB sweep.
- Output impedance 1 kΩ.

Fitting the output:

- Fit the connector in the relevant hole in the rear panel of the oscilloscope.
- Connect one end of the coaxial cable to the coax socket MTB gate out on the time-base unit (unit 8): this socket is indicated on the unit lay-out.
  Connect the other end of this cable to the BNC connector on the rear panel.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

- BNC connector — ordering code 5322 267 10004
- Coax Cable (per meter) — ordering code 5322 320 10003

3.6.3. **Delayed time-base gate output** (Optionally available)

Characteristics:

- Output voltage 0 ... +5 V delivered during DTB sweep.
- Output impedance 1 kΩ.

Fitting the output:

- Fit the connector in the relevant hole in the rear panel of the oscilloscope.
- Connect one end of the coaxial cable to the coax socket DTB gate out on the time base unit (unit 8): this socket is indicated on the unit lay-out.
  Connect the other end of this cable to the BNC connector on the rear panel.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

- BNC connector — ordering code 5322 267 10004
- Coax Cable (per meter) — ordering code 5322 267 10004

3.7. MAINTENANCE

Cleaning the nextel suède coating of the top and bottom cover plates of the instrument.

WARNING: The Nextel suède coating is ethanol-resistant, but is susceptible to methylated spirit, which will attack the surface (due to one of the de-naturing substances).

The bright appearance of the top and bottom cover, lacquered with Nextel suède coating will deteriate after some time as the surface becomes soiled. Cleaning with a cloth soaked in water, ethanol or a common household cleansing agent does not always restore this lustre and leaves dirt in the holes and the pores.

The 3M Company have developed a new cleansing pad (White Cleansing Pad, Catalogue No. 8440) which when soaked in water, ethanol or a common household cleansing agent will also penetrate holes and pores. This meathod is similar to that of abrasive cleaning pads but lacks their abrasive action.
Abrasive cleaning pads should not be used, otherwise scratches will result.

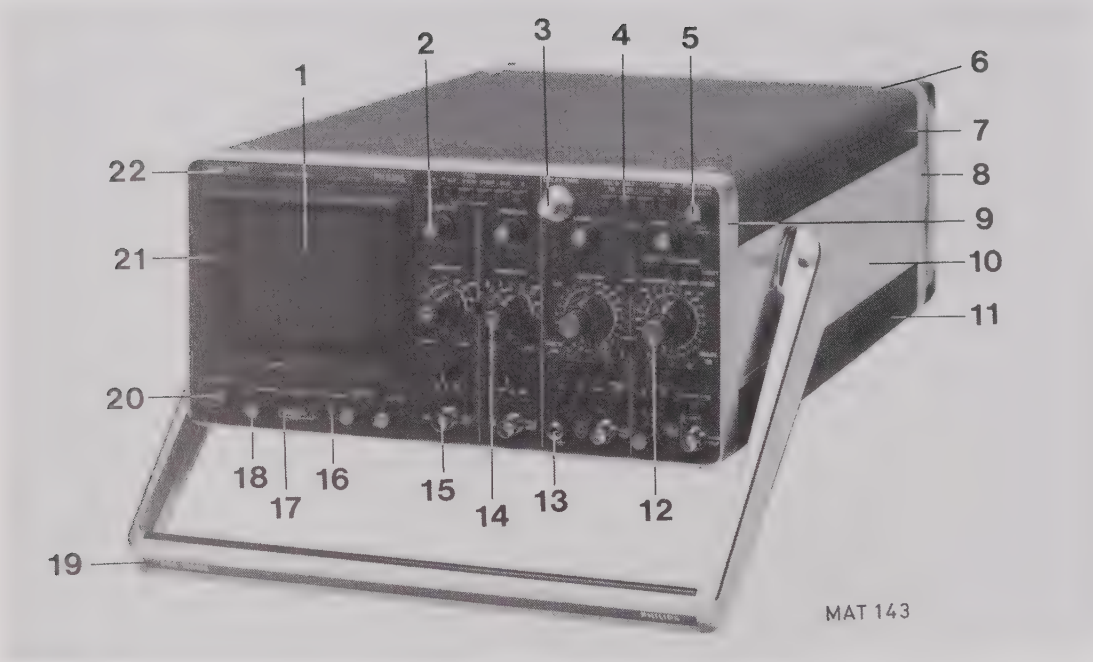


Fig. 3.42. Electrical item numbers Front

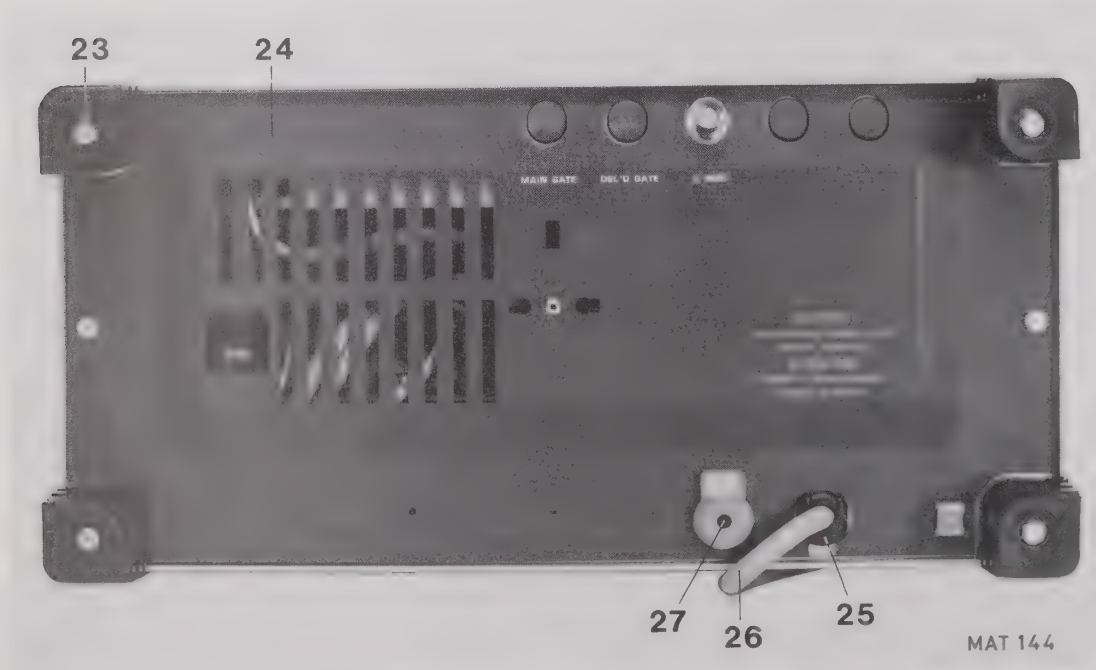


Fig. 3.43. Electrical item numbers Rear.

3.8. PARTS LISTS AND DIAGRAMS

3.8.1. Mechanical parts (Fig. 3.34. and 3.35.)

Item	*Qty*	*Order number*	*Description*	*Used for*
3	1	5322 414 34147	Ten turn dial knob delay time	R1
		5322 414 34091	Knob dia 10 mm, 4 mm shaft	R3/S4
2	3	5322 414 74028	Skirt	R4/S5
		5322 414 74015	Cover grey with line	R18
5	3	5322 414 34191	Knob dia 10 mm, 4 mm shaft	R5/S6 R7/S7
		5322 414 74015	Cover grey with line	R2/S3
4	1	5322 414 34217	Knob dia 6,7 - 10 mm, 4 mm shaft	R6
		5322 492 64337	Clamping spring	
		5322 414 34079	Knob dia 18,7 mm 6 mm shaft	
14	2	5322 414 34134	Knob dia 10 mm, 4 mm shaft	R8/S9/S10
		5322 492 64337	Clamping spring	R9/S11/S12
		5322 414 74029	Cover blue with line	
		5322 414 34081	Knob dia 24 mm, 6 mm shaft	R10/S13/S14
12	2	5322 414 34119	Knob dia 14 mm, 4 mm shaft	R11/S15/S16
		5322 414 74016	Cover blue with dash	
		5322 414 34223	Knob dia 14 mm, 4 mm shaft	R14/S23
18	3	5322 492 64337	Clamping spring	R16/S26
		5322 414 74015	Cover grey with line	R17
17	30	5322 414 14011	Pushbutton knob grey	
16	1	5322 414 24911	Pushbutton knob red	
		5322 267 14014	CAL socket	
20	1	5322 505 14184	Plastic nut	X1/X2
		5322 405 94073	Current loop	
		5322 263 54003	BNC adaptor for CAL socket	
15	5	5322 267 10004	BNC socket	X3,4,6,7,8
13	1	5322 535 80523	Earth socket	X5
		5322 505 14178	Serrated nut	
21	1	5322 466 74059	Screen bezel	
1	1	5322 480 34046	Contrast filter grey	
1	1	5322 480 34073	Contrast filter blue	
	1	5322 498 54082	Set grip and brackets	
	2	5322 535 74401	Locking pin	
19	2	5322 492 54155	Spring	Carrying handle
	1	5322 498 54042	Plastic protection strip	
	1	5322 455 84079	Text strip PM 3266	
	1	5322 447 94169	Front cover complete	
7	1	5322 447 94482	Upper cabinet plate complete	
11	1	5322 447 94483	Lower cabinet plate complete	
6	8	5322 417 24024	Quick fastener complete	
	4	5322 462 44297	Rubber foot for lower plate	
24	1	5322 447 94503	Rear cabinet plate	
23	4	5322 462 44154	Foot complete for rear panel	
9	1	5322 459 84023	Cast alluminium front plate	
8	1	5322 447 94504	Cast alluminium rear plate	
10	2	5322 460 64042	Side panel alluminium	
	8	4822 502 30047	Screw for fitting side panel	

Item	*Qty.*	*Order number*	*Description*
	–	4822 505 10029	Square nut M3 for side panel
26		5322 321 14066	Mains cable European plug
		5322 321 14017	Mains cable USA plug
25	1	5322 325 64061	Mains cable cleat
27	1	5322 256 34019	Fuse holder
	1	4822 253 30025	Fuse 2 A slow blow
	4	5322 255 44088	Holder for LED
	6	5322 405 94074	Male clamping piece for pushbutton set
	6	5322 405 94075	Female clamping piece for pushbutton set
	6	4822 502 11142	Screw M3x20 for clamping pieces
	1	5322 380 24088	Clamp for CRT screen top
	1	5322 380 24087	Clamp for CRT screen bottom
	1	5322 535 74525	Plastic spindle for R14
	1	5322 532 24398	Coupling piece
	2	5322 535 74526	Plastic spindle for R16 and R17
	2	5322 492 64337	Clamping spring
	2	5322 505 14185	Nut for attenuator switch
	–	5322 395 54023	Tool for attenuator nut
	2	5322 505 14186	Nut for Level/Slope potentiometers
	–	5322 395 54024	Tool for Level/Slope nut
	29	5322 276 14158	Pushbutton switch element
	–	5322 320 14102	Set of coaxial cables
	20	5322 268 24116	PC board vertical coax socket
	20	5322 268 14141	Contact pin for coax socket
	1	5322 455 84078	Textplate PM 3266
	1	5322 466 34013	CRT shield
	–	4822 390 20023	Grease for EHT connector Dow Corning "4 Compound" Silicon Dielectric
	18	4822 265 30121	3 pole socket "stocko"
	18	4822 266 30071	3 pole plug "stocko"
	14	4822 265 30119	4 pole socket "stocko"
	14	4822 266 30072	4 pole plug "stocko"
	16	4822 265 30117	6 pole socket "stocko"
	16	4822 266 30073	6 pole plug "stocko"
	10	4822 265 40119	7 pole socket "stocko"
	10	4822 266 40057	7 pole plug "stocko"
	1	5322 273 14054	MTB switch S15
	1	5322 273 14055	DTB switch S13
	1	5322 693 84003	Attenuator (Unit 2)
	1	5322 216 54202	Attenuator p.c. board
	1	5322 278 94078	Attenuator contract array
	2	5322 273 34116	Attenuator switch segment S9/S11
	1	5322 121 44257	Mains filter (Unit 3)
	1	5322 320 44039	Delay line (Unit 4)
	1	5322 216 54204	Power supply (Unit 5)

Item	*Qty*	*Order number*	*Description*
	1	5322 216 54217	Focus unit (Unit 7)
		5322 390 34006	"Coating for focus unit Dow Corning 3140 RTV".
	1	5322 216 54205	Time base (Unit 8)
	1	5322 216 54195	Trigger amplifier (Unit 9)
	1	5322 216 54218	Z-amplifier (Unit 11)
	1	5322 216 54196	Intermediate amplifier (Unit 12)
	1	5322 216 54197	Final Y-amplifier (Unit 13)
	1	5322 218 64109	E.H.T. unit (Unit 15)
	1	5322 216 54199	Trigger source selector (Unit 16)
	1	5322 216 54219	Storage logic (Unit 22)
	1	5322 216 54221	Additional power supply (Unit 24)
	1	5322 216 54222	Storage amplifier (Unit 25)
	1	5322 216 54223	Final X-amplifier (Unit 26)

3.8.2. Electrical parts.

Miscellaneous

Item	*Ordering numbers*	*Type/description*
K1701	5322 280 24076	Relay coil
L1	5322 157 44035	Choke
L601	5322 321 24901	R/L combination
L602	5322 321 24901	R/L combination
L1601	5322 156 14076	Choke
L1801	5322 156 14076	Choke
L1802	5322 156 14076	Choke
L1803	5322 142 44026	Driver transformer
L1804	5322 281 64154	Choke
L1806	5322 148 84041	Feed back transf.
L1807	5322 152 24062	Choke
L1811	4822 156 20663	Choke
L1812	4822 156 20663	Choke
L1813	4822 156 20663	Choke
L1814	4822 156 20663	Choke
L1816	5322 152 24067	Choke
L1817	5322 152 24068	Choke
L1876	5322 152 24074	Choke
L1877	5322 152 24068	Choke
L1878	5322 152 24071	Choke
T1801	5322 148 84039	Converter transf.
T1876	5322 146 24446	H.F. transformer
S1	5322 267 64029	Vertical display mode switch
S2	5322 276 44063	Horizontal display mode switch
S8	5322 276 34043	Auto, trigger, single switch
S9	5322 273 34116	Segment switch AC/0/DC
S11	5322 273 34116	Segment switch AC/0/DC
S13	5322 273 44098	Segment switch DTB
S15	5322 273 44097	Segment switch MTB
S19	5322 276 64031	Trigger coupling switch
S21	5322 276 84063	Trigger source switch
S1801	5322 277 24071	Mains voltage selector

Item	Ordering number	Farad	Tol%	Volts	Remarks
Capacitors					
C 1	5322 122 14018				CERAMIC TUBULAR
C 2	5322 125 54003				TRIMMER
C 3	4822 122 31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 101	5322 125 54026	3PF	0,5PF	400V	TRIMMER
C 102	4822 121 40171	22NF	10	400V	POLYESTER FOIL
C 103	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 104	5322 125 50048	3,5PF	–	300V	TRIMMER
C 106	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 107	5322 125 50051	18PF	–	300V	TRIMMER
C 108	5322 122 34105	33PF	10	50V	CERAMIC PLATE
C 109	5322 125 50049	10PF	–	300 V	TRIMMER
C 111	4822 122 31182	1PF	0,25PF	500	CERAMIC PLATE
C 112	5322 125 50051	18PF	–	300V	TRIMMER
C 113	5322 122 34113	39PF	5	50V	CERAMIC PLATE
C 114	4822 122 31081	100PF	2	500	CERAMIC PLATE
C 116	5322 122 34103	5,6PF	0,5PF	50	CERAMIC PLATE
C 117	5322 122 34098	10NF	20	50V	CERAMIC PLATE
C 118	4822 122 30105	1,5PF	0,25PF	100	CERAMIC PLATE
C 119	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 121	4822 122 31116	2,2NF	-20+80	40	CERAMIC PLATE
C 122	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 123	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 124	5322 124 14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 126	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 127	5322 124 14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 128	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 151	5322 125 54026	3PF	0,5PF	400V	TRIMMER
C 152	4822 121 40171	22NF	10	400V	POLYESTER FOIL
C 153	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 154	5322 125 50048	3,5PF	–	300V	TRIMMER
C 156	4822 122 31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 157	5322 125 50051	18PF	–	300V	TRIMMER
C 158	5322 122 34105	33PF	10	50V	CERAMIC PLATE
C 159	5322 125 50049	10PF	–	300V	TRIMMER
C 161	4822 122 31182	1PF	0,25PF	500	CERAMIC PLATE
C 162	5322 125 50051	18PF	–	300V	TRIMMER
C 163	5322 122 34113	39PF	5	50V	CERAMIC PLATE
C 164	4822 122 31081	100PF	2	500	CERAMIC PLATE
C 166	5322 122 34103	5,6PF	0,5PF	50	CERAMIC PLATE
C 167	5322 122 34098	10NF	20	50V	CERAMIC PLATE
C 168	4822 122 30105	1,5PF	0,25PF	100	CERAMIC PLATE
C 169	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 171	4822 122 31116	2,2NF	-20+80	40	CERAMIC PLATE
C 172	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 173	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 174	5322 124 14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 176	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 177	5322 124 14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 178	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 201	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 202	4822 122 31056	12PF	2	100	CERAMIC PLATE
C 204	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 205	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 206	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 207	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 208	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 209	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 210	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 211	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 212	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 213	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 214	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 215	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 216	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 217	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 218	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 219	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 220	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE

C 221	5322 125 50049	10PF	–	300V	TRIMMER
C 225	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 226	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 227	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 228	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 229	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 231	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 232	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 233	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 234	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 236	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 237	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 241	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 242	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 243	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 244	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 301	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 302	4822 122 31056	12PF	2	100	CERAMIC PLATE
C 303	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 304	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 305	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 306	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 307	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 308	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 309	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 310	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 311	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 312	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 313	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 314	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 315	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 316	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 317	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 318	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 319	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 321	5322 125 50049	10PF	–	300V	TRIMMER
C 325	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 326	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 327	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 328	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 329	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 331	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 332	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 333	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 334	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 336	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 337	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 341	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 342	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 343	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 344	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 400	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 401	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 402	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 404	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 408	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 409	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 411	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 414	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 417	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 418	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 450	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 451	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 452	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 454	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 458	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 459	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 461	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 464	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 466	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE

C 467	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 468	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 501	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 502	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 503	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 504	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 506	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 507	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 508	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 509	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 601	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 602	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 603	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 604	4822 121 41161				POLYESTER FOIL
C 606	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 608	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 609	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 611	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 616	5322 125 50051	18PF	10	300V	TRIMMER
C 617	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 618	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 620	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 621	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 622	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 623	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 624	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 625	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 626	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 628	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 629	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 700	4822 122 31186	2,2PF	0,25PF	500	CERAMIC PLATE
C 701	4822 122 31194	8,2PF	0,25PF	500	CERAMIC PLATE
C 702	5322 122 34094	82PF	2	100	CERAMIC PLATE
C 703	4822 122 31211	100PF	10	500	CERAMIC PLATE
C 704	4822 121 40349	22NF	10	400V	POLYESTER FOIL
C 705	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 706	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 707	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 708	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 709	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 710	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 711	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 712	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 713	5322 122 34094	82PF	2	100	CERAMIC PLATE
C 714	4822 122 31215	0,68PF	0,25PF	100	CERAMIC PLATE
C 800	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 801	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 802	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 803	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 804	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 805	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 806	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 807	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 808	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 809	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 810	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 811	4822 121 41161	100NF	10	250V	POLYESTER FOIL
C 812	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 813	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 814	4822 122 31076	68PF	2	100	CERAMIC PLATE
C 815	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 816	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 817	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 818	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 819	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 820	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 821	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 822	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 823	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 826	4822 122 31081	100PF	2	100	CERAMIC PLATE

C 827	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 828	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 829	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 830	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 831	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 832	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 900	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 901	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 903	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 904	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 907	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 908	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 909	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 911	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 912	5322 121 40224	4,7UF	10	100	POLYESTER FOIL
C 913	5322 121 54108	47NF	1	63	POLYSTYRENE FOIL
C 914	5322 121 54062	4,3NF	1	63	POLYSTYRENE FOIL
C 915	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 916	5322 125 54003	60PF	–	300	TRIMMER
C 917	4822 121 50418	390PF	1	250	POLYSTYRENE FOIL
C 918	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 919	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 921	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 922	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 923	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 924	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 926	4822 121 40438	470NF	10	100	POLYESTER FOIL
C 927	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 928	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 929	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 930	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 931	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 932	4822 122 31189	4,7PF	0,25PF	500	CERAMIC PLATE
C 1100	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 1101	4822 122 31211	100PF	10	500	CERAMIC PLATE
C 1102	4822 121 40349	22NF	10	400	POLYESTER FOIL
C 1103	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1104	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 1106	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 1201	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1202	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1203	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1204	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1205	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1206	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1207	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1208	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1209	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1210	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1211	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1212	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 1213	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1215	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1216	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1220	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1222	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1223	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1228	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1301	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1302	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1303	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1304	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1305	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 1306	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1307	5322 121 40224	4,7UF	10	100	POLYESTER FOIL
C 1308	5322 121 54108	47NF	1	63	POLYSTYRENE FOIL
C 1309	5322 121 54062	4,3NF	1	63	POLYSTYRENE FOIL
C 1311	5322 125 54003	60PF	–	300	TRIMMER
C 1312	4822 121 50418	390PF	1	250	POLYSTYRENE FOIL
C 1313	4822 121 41161	100NF	10	250	POLYESTER FOIL

C 1314	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 1315	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1316	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1317	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1318	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 1319	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1320	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1321	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1322	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1323	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1325	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 1550	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1551	4822 121 41161			250	POLYESTER FOIL
C 1552	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1553	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1554	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1557	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1559	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1561	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1562	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1563	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1564	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1567	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1569	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1601	4822 122 31243	82PF	2	100	CERAMIC PLATE
C 1602	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1603	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 1604	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1605	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 1606	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1608	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1609	4822 124 20476	22UF	-10+50	25	ELECTROLYTIC
C 1611	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1612	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 1650	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1651	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1652	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1653	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1654	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1656	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1658	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1659	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1660	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1661	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1662	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1663	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1664	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1666	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1667	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1668	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1669	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1671	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 1672	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1673	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1674	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1675	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1676	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1677	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1678	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1679	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1701	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1702	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1706	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 1801	5322 121 44142	220NF	10	250	POLYESTER FOIL
C 1802	5322 124 44007	220UF	-10+50	350	ELECTROLYTIC
C 1803	5322 124 44007	220UF	-10+50	350	ELECTROLYTIC
C 1804	4822 121 40342	47NF	10	630	POLYESTER FOIL
C 1806	5322 122 54024	270PF	10	2000	CERAMIC DISK
C 1807	5322 121 44248	30,1NF	2	500	POLYESTER FOIL
C 1808	5322 121 44248	30,1NF	2	500	POLYESTER FOIL

C 1809	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1811	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1812	5322 121 54049	3,3NF	1	63	POLYSTYRENE FOIL
C 1813	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1814	5322 124 24089	10UF	-20+20	16	ELECTROLYTIC
C 1816	5322 124 24089	10UF	-20+20	16	ELECTROLYTIC
C 1817	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1818	5322 124 24089	10UF	-20+20	16	ELECTROLYTIC
C 1819	5322 124 24187	33UF	-20+20	16	ELECTROLYTIC
C 1821	5322 124 24099	22UF	-20+20	25	ELECTROLYTIC
C 1826	4822 122 31166	560PF	10	500	CERAMIC PLATE
C 1828	5322 124 24212	220UF	-20+20	6,3	ELECTROLYTIC
C 1829	5322 124 24212	220UF	-20+20	6,3	ELECTROLYTIC
C 1831	5322 124 24155	100UF	-20+20	16	ELECTROLYTIC
C 1832	5322 124 24155	100UF	-20+20	16	ELECTROLYTIC
C 1833	4822 121 40456	2,2UF	10	100	POLYESTER FOIL
C 1834	4822 121 40456	2,2UF	10	100	POLYESTER FOIL
C 1836	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1837	4822 121 40411	33NF	10	250	POLYESTER FOIL
C 1838	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1839	5322 124 24089	10UF	-20+20	16	ELECTROLYTIC
C 1841	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1851	5322 122 54004	470PF	20	4KV	CERAMIC DISK
C 1852	5322 122 54004	470PF	20	4KV	CERAMIC DISK
C 1853	5322 122 54004	470PF	20	4KV	CERAMIC DISK
C 1854	5322 122 54004	470PF	20	4KV	CERAMIC DISK
C 1856	5322 122 24001	600PF	20	9KV	CERAMIC TUBULAR
C 1876	4822 121 40407	22NF	10	630	POLYESTER FOIL
C 1877	4822 121 40407	22NF	10	630	POLYESTER FOIL
C 1878	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1879	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1881	4822 121 40239	47NF	10	400	POLYESTER FOIL
C 1882	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1901	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 1902	5322 121 40233	680NF	10	100	POLYESTER FOIL
C 1903	4822 121 50611	20NF	1	63	POLYSTYRENE FOIL
C 1904	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2001	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2002	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2003	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 2006	4822 122 31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 2008	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2011	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2012	4822 122 31214	0,82PF	0,25PF	100	CERAMIC PLATE
C 2013	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 2016	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2017	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2018	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2021	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2022	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2023	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 2026	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 2027	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2028	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2031	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2032	5322 121 54044	1,8NF	1	63	POLYSTYRENE FOIL
C 2033	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 2051	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2052	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2053	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2054	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2056	4822 122 30114	2,2NF	10	100	CERAMIC PLATE
C 2057	4822 122 30114	2,2NF	10	100	CERAMIC PLATE
C 2062	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2064	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2066	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2067	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2076	4822 122 31175	1NF	-20+50	4K	CERAMIC PLATE
C 2077	5322 122 34112	4,7NF	-20+50	4K	CERAMIC PLATE
C 2078	4822 122 31211	100PF	10	500	CERAMIC PLATE

C 2079	5322 122 34112	4,7NF	-20+50	4K	CERAMIC PLATE
C 2081	5322 122 34112	4,7NF	-20+50	4K	CERAMIC PLATE
C 2082	5322 122 34112	4,7NF	-20+50	4K	CERAMIC PLATE
C 2083	4822 122 31175	1NF	-20+50	4K	CERAMIC PLATE
C 2084	4822 122 31175	1NF	-20+50	4K	CERAMIC PLATE
C 2086	5322 122 50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2087	5322 122 50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2088	5322 122 50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2089	5322 122 54007	220PF	20	5KV	CERAMIC DISK
C 2202	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2203	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2208	4822 121 41161	100NF	10		POLYESTER FOIL
C 2209	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2212	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2213	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2214	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2216	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2217	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2218	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2219	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2222	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 2223	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2227	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 2228	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 2229	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2231	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2232	4822 122 31164	1,8NF	10	100	CERAMIC PLATE
C 2238	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2239	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2244	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2401	4822 121 41161	100NF	10		POLYESTER FOIL
C 2402	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2403	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2404	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 2406	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2407	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2408	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2409	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2410	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2411	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 2412	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 2413	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2414	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2415	4822 124 20475	10UF	-10+50	25	ELECTROLYTIC
C 2416	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2417	4822 121 41134	10NF	10	630	POLYESTER FOIL
C 2418	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2419	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2421	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2422	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 2424	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2426	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 2427	4822 124 20584	2,2UF	-10+50	63	ELECTROLYTIC
C 2429	4822 121 41161	100NF	10	250	POLYESTER FOIL

Item	Ordering number	OHM	Tol%	Type	Remarks
Resistors					
R 1	5322 103 54027	5K	5	2W	MULTITURN W-W POTENTIOMETER
R 2	5322 102 44006	2X47K	–	–	CARBON TANDEM POTM + SWITCH
R 3	5322 101 44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 4	5322 101 44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 5	5322 101 44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 6	5322 101 24129	4,7K	20	0.1W	CARBON POTM LIN
R 7	5322 101 44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 8	5322 101 44038	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 9	5322 101 44038	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 10	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 11	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 12	5322 101 24148	10K	20	0.1W	CARBON POTM LIN
R 13	5322 101 24148	10K	20	0.1W	CARBON POTM LIN
R 14	5322 101 24055	25K	20		CARBON POTM LIN
R 15	4822 101 20417	22K	20	0.1W	CARBON POTM LIN
R 16	5322 102 44007	10K	20	0.1W	CARBON TANDEM POTM + SWITCH
R 17	5322 101 24156	10K	20	0.1W	CARBON POTM LIN
R 18	5322 102 34019	2X4,7K	20	0.1W	CARBON TANDEM POTM
R 19	4822 101 20441	10K	20	0.1W	CARBON POTM LIN
R 100	5322 116 50452	10	1	MR25	METAL FILM
R 101	5322 111 44121	1,8M	5	0,125W	CARBON
R 102	5322 116 64045	10	5	0.125W	METAL OXIDE
R 103	4822 116 51123	1K	5	0.125W	METAL FILM
R 104	5322 116 55152	900K	0,5	SPEC	METAL FILM
R 105	5322 116 64046	51	5	0.125W	METAL OXIDE
R 106	5322 116 55316	111K	0,5	MR25	METAL FILM
R 107	5322 116 64049	47	5	0.125W	METAL OXIDE
R 108	4822 116 51123	1K	5	0.125W	METAL FILM
R 109	5322 116 55153	992K	0,5	SPEC	METAL FILM
R 111	5322 116 55285	10,1K	0,5	MR25	METAL FILM
R 112	5322 116 64049	47	5	0.125W	METAL OXIDE
R 113	5322 116 64051	15	5	0.125W	METAL OXIDE
R 114	5322 111 30376	100M	5	0,125W	CARBON
R 116	5322 116 64051	15	5	0.125W	METAL OXIDE
R 117	5322 116 54442	51,1	1	MR25	METAL FILM
R 118	5322 116 54576	2,37K	1	MR25	METAL FILM
R 119	5322 116 50572	12,1K	1	MR25	METAL FILM
R 121	5322 116 54536	750	1	MR25	METAL FILM
R 122	5322 116 54335	750K	1	MR30	METAL FILM
R 123	5322 116 54735	255K	1	MR25	METAL FILM
R 124	5322 100 10143	1K	20	0.75W	TRIMMING POTM
R 126	5322 116 54038	221K	1	MR25	METAL FILM
R 127	4822 110 42214	10M	5	VR37	CARBON
R 128	4822 110 42227	33M	5	VR37	CARBON
R 129	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 131	5322 116 54595	5,11K	1	MR25	METAL FILM
R 132	5322 101 14056	47K	20	0.75W	TRIMMING POTM
R 133	5322 116 54696	100K	1	MR25	METAL FILM
R 134	5322 116 54743	301K	1	MR25	METAL FILM
R 141	5322 116 54504	274	1	MR25	METAL FILM
R 150	5322 116 50452	10	1	MR25	METAL FILM
R 151	5322 111 44121	1,8M	5	0,125W	CARBON
R 152	5322 116 64045	10	5	0.125W	METAL OXIDE
R 153	4822 116 51123	1K	5	0.125W	METAL FILM
R 154	5322 116 55152	900K	0,5	SPEC	METAL FILM
R 155	5322 116 64046	51	5	0.125W	METAL OXIDE
R 156	5322 116 55316	111K	0,5	MR25	METAL FILM
R 157	5322 116 64049	47	5	0.125W	METAL OXIDE
R 158	4822 116 51123	1K	5	0.125W	METAL FILM
R 159	5322 116 55153	992K	0,5	SPEC	METAL FILM
R 161	5322 116 55285	10,1K	0,5	MR25	METAL FILM
R 162	5322 116 64049	47	5	0.125W	METAL OXIDE
R 163	5322 116 64051	15	5	0.125W	METAL OXIDE
R 164	5322 111 30376	100M	5	0,125W	CARBON
R 166	5322 116 64051	15	5	0.125W	METAL OXIDE
R 167	5322 116 54442	51,1	1	MR25	METAL FILM
R 168	5322 116 54576	2,37K	1	MR25	METAL FILM
R 169	5322 116 50572	12,1K	1	MR25	METAL FILM

R 171	5322 116 54536	750	1	MR25	METAL FILM
R 172	5322 116 54335	750K	1	MR30	METAL FILM
R 173	5322 116 54735	255K	1	MR25	METAL FILM
R 174	5322 100 10143	1K	20	0.75W	TRIMMING POTM
R 176	5322 116 54038	221K	1	MR25	METAL FILM
R 177	4822 110 42214	10M	5	VR37	CARBON
R 178	4822 110 42227	33M	5	VR37	CARBON
R 179	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 181	5322 116 54595	5,11K	1	MR25	METAL FILM
R 182	5322 101 14056	47K	20	0.75W	TRIMMING POTM
R 183	5322 116 54696	100K	1	MR25	METAL FILM
R 184	5322 116 54743	301K	1	MR25	METAL FILM
R 191	5322 116 54504	274	1	MR25	METAL FILM
R 201	5322 116 50621	536	1	MR25	METAL FILM
R 202	5322 116 50904	30,1	1	MR25	METAL FILM
R 203	5322 116 54442	51,1	1	MR25	METAL FILM
R 204	5322 116 50452	10	1	MR25	METAL FILM
R 206	5322 116 50904	30,1	1	MR25	METAL FILM
R 207	5322 116 54448	59	1	MR25	METAL FILM
R 208	5322 116 64071	160	5	0.125W	METAL OXIDE
R 209	5322 116 54549	1K	1	MR25	METAL FILM
R 210	5322 116 50536	464	1	MR25	METAL FILM
R 211	5322 116 54469	100	1	MR25	METAL FILM
R 212	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 213	5322 116 50583	5,9K	1	MR25	METAL FILM
R 214	5322 116 54469	100	1	MR25	METAL FILM
R 215	5322 116 54469	100	1	MR25	METAL FILM
R 216	5322 116 50608	6,19K	1	MR25	METAL FILM
R 217	5322 116 50593	16,2K	1	MR25	METAL FILM
R 218	5322 116 54511	316	1	MR25	METAL FILM
R 219	5322 116 50636	2,74K	1	MR25	METAL FILM
R 220	5322 116 64071	160	5	0.125W	METAL OXIDE
R 221	5322 116 54469	100	1	MR25	METAL FILM
R 222	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 223	5322 116 54619	10K	1	MR25	METAL FILM
R 224	5322 116 54499	249	1	MR25	METAL FILM
R 225	5322 116 54549	1K	1	MR25	METAL FILM
R 226	5322 116 54469	100	1	MR25	METAL FILM
R 227	5322 116 54499	249	1	MR25	METAL FILM
R 228	5322 116 54446	56,2	1	MR25	METAL FILM
R 229	5322 116 54455	68,1	1	MR25	METAL FILM
R 230	5322 116 54469	100	1	MR25	METAL FILM
R 231	5322 116 54497	226	1	MR25	METAL FILM
R 232	5322 116 54469	100	1	MR25	METAL FILM
R 233	5322 116 54455	68,1	1	MR25	METAL FILM
R 234	5322 116 54497	226	1	MR25	METAL FILM
R 235	5322 116 54597	5,36K	1	MR25	METAL FILM
R 236	5322 116 54446	56,2	1	MR25	METAL FILM
R 237	5322 116 54469	100	1	MR25	METAL FILM
R 238	5322 116 50452	10	1	MR25	METAL FILM
R 239	5322 116 50452	10	1	MR25	METAL FILM
R 240	5322 116 54585	3,48K	1	MR25	METAL FILM
R 241	5322 116 54696	100K	1	MR25	METAL FILM
R 242	5322 116 54696	100K	1	MR25	METAL FILM
R 246	5322 116 54585	3,48K	1	MR25	METAL FILM
R 247	5322 116 50452	10	1	MR25	METAL FILM
R 248	5322 116 50678	20,5	1	MR25	METAL FILM
R 249	5322 116 54525	511	1	MR25	METAL FILM
R 251	5322 116 50678	20,5	1	MR25	METAL FILM
R 252	5322 116 50452	10	1	MR25	METAL FILM
R 253	5322 100 10138	100	20	0.75W	TRIMMING POTM
R 254	5322 100 10144	2,2K	20	0.75W	TRIMMING POTM
R 255	5322 100 10139	4,7K	20	0.75W	TRIMMING POTM
R 257	5322 116 54469	100	1	MR25	METAL FILM
R 258	5322 116 50583	5,9K	1	MR25	METAL FILM
R 259	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 261	5322 116 50484	4,64K	1	MR25	METAL FILM
R 262	5322 116 50484	4,64K	1	MR25	METAL FILM
R 263	5322 116 54619	10K	1	MR25	METAL FILM
R 264	5322 116 54469	100	1	MR25	METAL FILM

R 266	5322 116 54469	100	1	MR25	METAL FILM
R 267	5322 116 54595	5,11K	1	MR25	METAL FILM
R 268	5322 116 54595	5,11K	1	MR25	METAL FILM
R 269	5322 116 54469	100	1	MR25	METAL FILM
R 271	5322 116 54469	100	1	MR25	METAL FILM
R 272	5322 116 54597	5,36K	1	MR25	METAL FILM
R 273	5322 116 54469	100	1	MR25	METAL FILM
R 274	5322 116 54585	3,48K	1	MR25	METAL FILM
R 276	5322 116 54529	619	1	MR25	METAL FILM
R 277	5322 116 54532	649	1	MR25	METAL FILM
R 278	5322 116 54532	649	1	MR25	METAL FILM
R 279	5322 116 54469	100	1	MR25	METAL FILM
R 281	5322 116 54549	1K	1	MR25	METAL FILM
R 283	5322 116 54549	1K	1	MR25	METAL FILM
R 284	5322 116 54469	100	1	MR25	METAL FILM
R 289	5322 116 54469	100	1	MR25	METAL FILM
R 291	5322 116 50484	4,64K	1	MR25	METAL FILM
R 301	5322 116 50621	536	1	MR25	METAL FILM
R 302	5322 116 50904	30,1	1	MR25	METAL FILM
R 303	5322 116 54442	51,1	1	MR25	METAL FILM
R 304	5322 116 50452	10	1	MR25	METAL FILM
R 306	5322 116 50904	30,1	1	MR25	METAL FILM
R 307	5322 116 54448	59	1	MR25	METAL FILM
R 308	5322 116 64071	160	5	0.125W	METAL OXIDE
R 309	5322 116 54549	1K	1	MR25	METAL FILM
R 310	5322 116 50536	464	1	MR25	METAL FILM
R 311	5322 116 54469	100	1	MR25	METAL FILM
R 312	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 313	5322 116 50583	5,9K	1	MR25	METAL FILM
R 314	5322 116 54469	100	1	MR25	METAL FILM
R 315	5322 116 54469	100	1	MR25	METAL FILM
R 316	5322 116 50608	6,19K	1	MR25	METAL FILM
R 317	5322 116 50593	16,2K	1	MR25	METAL FILM
R 318	5322 116 54511	316	1	MR25	METAL FILM
R 319	5322 116 50636	2,74K	1	MR25	METAL FILM
R 320	5322 116 64071	160	5	0.125W	METAL OXIDE
R 321	5322 116 54469	100	1	MR25	METAL FILM
R 322	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 323	5322 116 54619	10K	1	MR25	METAL FILM
R 324	5322 116 54499	249	1	MR25	METAL FILM
R 325	5322 116 54549	1K	1	MR25	METAL FILM
R 326	5322 116 54469	100	1	MR25	METAL FILM
R 327	5322 116 54499	249	1	MR25	METAL FILM
R 328	5322 116 54446	56,2	1	MR25	METAL FILM
R 329	5322 116 54455	68,1	1	MR25	METAL FILM
R 330	5322 116 54469	100	1	MR25	METAL FILM
R 331	5322 116 54497	226	1	MR25	METAL FILM
R 332	5322 116 54469	100	1	MR25	METAL FILM
R 333	5322 116 54455	68,1	1	MR25	METAL FILM
R 334	5322 116 54497	226	1	MR25	METAL FILM
R 335	5322 116 54597	5,36K	1	MR25	METAL FILM
R 336	5322 116 54446	56,2	1	MR25	METAL FILM
R 337	5322 116 54469	100	1	MR25	METAL FILM
R 338	5322 116 50452	10	1	MR25	METAL FILM
R 339	5322 116 50452	10	1	MR25	METAL FILM
R 340	5322 116 54585	3,48K	1	MR25	METAL FILM
R 341	5322 116 54696	100K	1	MR25	METAL FILM
R 342	5322 116 54696	100K	1	MR25	METAL FILM
R 346	5322 116 54585	3,48K	1	MR25	METAL FILM
R 347	5322 116 50452	10	1	MR25	METAL FILM
R 348	5322 116 50678	20,5	1	MR25	METAL FILM
R 349	5322 116 54525	511	1	MR25	METAL FILM
R 351	5322 116 50678	20,5	1	MR25	METAL FILM
R 352	5322 116 50452	10	1	MR25	METAL FILM
R 357	5322 116 54469	100	1	MR25	METAL FILM
R 358	5322 116 50583	5,9K	1	MR25	METAL FILM
R 359	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 361	5322 116 50484	4,64K	1	MR25	METAL FILM
R 362	5322 116 50484	4,64K	1	MR25	METAL FILM
R 363	5322 116 54619	10K	1	MR25	METAL FILM

R 364	5322 116 54469	100	1	MR25	METAL FILM
R 366	5322 116 54469	100	1	MR25	METAL FILM
R 367	5322 116 54595	5,11K	1	MR25	METAL FILM
R 368	5322 116 54595	5,11K	1	MR25	METAL FILM
R 369	5322 116 54469	100	1	MR25	METAL FILM
R 371	5322 116 54469	100	1	MR25	METAL FILM
R 372	5322 116 54597	5,36K	1	MR25	METAL FILM
R 373	5322 116 54469	100	1	MR25	METAL FILM
R 374	5322 116 54585	3,48K	1	MR25	METAL FILM
R 376	5322 116 54529	619	1	MR25	METAL FILM
R 377	5322 116 54532	649	1	MR25	METAL FILM
R 378	5322 116 54532	649	1	MR25	METAL FILM
R 379	5322 116 54469	100	1	MR25	METAL FILM
R 381	5322 116 54549	1K	1	MR25	METAL FILM
R 383	5322 116 54549	1K	1	MR25	METAL FILM
R 384	5322 116 54469	100	1	MR25	METAL FILM
R 389	5322 116 54469	100	1	MR25	METAL FILM
R 391	5322 116 50484	4,64K	1	MR25	METAL FILM
R 401	5322 116 54442	51,1	1	MR25	METAL FILM
R 402	5322 116 54516	365	1	MR25	METAL FILM
R 403	5322 116 50452	10	1	MR25	METAL FILM
R 404	5322 116 54585	3,48K	1	MR25	METAL FILM
R 405	5322 116 54469	100	1	MR25	METAL FILM
R 406	5322 116 54585	3,48K	1	MR25	METAL FILM
R 407	5322 116 54469	100	1	MR25	METAL FILM
R 408	5322 116 54499	249	1	MR25	METAL FILM
R 409	5322 116 50861	15,8	1	MR25	METAL FILM
R 411	5322 116 50568	4,99	1	MR25	METAL FILM
R 412	5322 116 50861	15,8	1	MR25	METAL FILM
R 413	5322 116 50568	4,99	1	MR25	METAL FILM
R 414	5322 116 50452	10	1	MR25	METAL FILM
R 415	5322 116 54549	1K	1	MR25	METAL FILM
R 416	5322 116 54516	365	1	MR25	METAL FILM
R 417	5322 116 54492	178	1	MR25	METAL FILM
R 418	5322 116 54696	100K	1	MR25	METAL FILM
R 419	5322 116 54469	100	1	MR25	METAL FILM
R 420	5322 116 54536	750	1	MR25	METAL FILM
R 421	5322 116 50583	5,9K	1	MR25	METAL FILM
R 422	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 423	5322 116 54469	100	1	MR25	METAL FILM
R 424	5322 116 50583	5,9K	1	MR25	METAL FILM
R 426	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 427	5322 116 50671	2,61K	1	MR25	METAL FILM
R 428	5322 116 54499	249	1	MR25	METAL FILM
R 429	5322 116 54558	8,25K	1	MR25	METAL FILM
R 431	5322 116 50572	12,1K	1	MR25	METAL FILM
R 433	5322 116 50664	2,05K	1	MR25	METAL FILM
R 434	5322 116 54619	10K	1	MR25	METAL FILM
R 436	5322 116 50671	2,61K	1	MR25	METAL FILM
R 451	5322 116 54442	51,1	1	MR25	METAL FILM
R 452	5322 116 54516	365	1	MR25	METAL FILM
R 453	5322 116 50452	10	1	MR25	METAL FILM
R 454	5322 116 54585	3,48K	1	MR25	METAL FILM
R 455	5322 116 54469	100	1	MR25	METAL FILM
R 456	5322 116 54585	3,48K	1	MR25	METAL FILM
R 457	5322 116 54469	100	1	MR25	METAL FILM
R 458	5322 116 54499	249	1	MR25	METAL FILM
R 459	5322 116 50861	15,8	1	MR25	METAL FILM
R 461	5322 116 50568	4,99	1	MR25	METAL FILM
R 462	5322 116 50861	15,8	1	MR25	METAL FILM
R 463	5322 116 50568	4,99	1	MR25	METAL FILM
R 464	5322 116 50452	10	1	MR25	METAL FILM
R 465	5322 116 54549	1K	1	MR25	METAL FILM
R 466	5322 116 54516	365	1	MR25	METAL FILM
R 467	5322 116 54492	178	1	MR25	METAL FILM
R 468	5322 116 54696	100K	1	MR25	METAL FILM
R 469	5322 116 54469	100	1	MR25	METAL FILM
R 470	5322 116 54536	750	1	MR25	METAL FILM
R 471	5322 116 50583	5,9K	1	MR25	METAL FILM
R 472	5322 100 10113	10K	20	0,5W	TRIMMING POTM

R 473	5322 116 54469	100	1	MR25	METAL FILM
R 474	5322 116 50583	5,9K	1	MR25	METAL FILM
R 476	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 477	5322 116 50671	2,61K	1	MR25	METAL FILM
R 478	5322 116 54499	249	1	MR25	METAL FILM
R 479	5322 116 54558	8,25K	1	MR25	METAL FILM
R 482	5322 116 50479	15,4K	1	MR25	METAL FILM
R 484	5322 116 54619	10K	1	MR25	METAL FILM
R 486	5322 116 50671	2,61K	1	MR25	METAL FILM
R 487	5322 116 54469	100	1	MR25	METAL FILM
R 488	5322 116 50484	4,64K	1	MR25	METAL FILM
R 489	5322 116 50479	15,4K	1	MR25	METAL FILM
R 501	5322 116 54455	68,1	1	MR25	METAL FILM
R 502	5322 116 54484	140	1	MR25	METAL FILM
R 503	5322 116 50511	48,7	1	MR25	METAL FILM
R 504	5322 116 54504	274	1	MR25	METAL FILM
R 506	5322 116 54499	249	1	MR25	METAL FILM
R 507	5322 116 54455	68,1	1	MR25	METAL FILM
R 508	5322 116 54484	140	1	MR25	METAL FILM
R 509	5322 116 54519	402	1	MR25	METAL FILM
R 511	5322 116 54442	51,1	1	MR25	METAL FILM
R 512	5322 116 50511	48,7	1	MR25	METAL FILM
R 513	5322 116 54504	274	1	MR25	METAL FILM
R 514	5322 116 54499	249	1	MR25	METAL FILM
R 516	5322 116 54448	59	1	MR25	METAL FILM
R 517	5322 116 50524	3,01K	1	MR25	METAL FILM
R 518	5322 116 50636	2,74K	1	MR25	METAL FILM
R 519	5322 116 54469	100	1	MR25	METAL FILM
R 521	5322 116 50621	536	1	MR25	METAL FILM
R 522	5322 116 54504	274	1	MR25	METAL FILM
R 523	5322 116 50621	536	1	MR25	METAL FILM
R 524	5322 116 54448	59	1	MR25	METAL FILM
R 526	5322 116 50583	5,9K	1	MR25	METAL FILM
R 527	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 528	5322 116 54469	100	1	MR25	METAL FILM
R 529	5322 116 50621	536	1	MR25	METAL FILM
R 531	5322 116 50452	10	1	MR25	METAL FILM
R 534	5322 116 50904	30,1	1	MR25	METAL FILM
R 536	5322 116 54534	681	1	MR25	METAL FILM
R 537	5322 116 50904	30,1	1	MR25	METAL FILM
R 539	5322 116 54549	1K	1	MR25	METAL FILM
R 542	5322 116 50452	10	1	MR25	METAL FILM
R 543	5322 116 54469	100	1	MR25	METAL FILM
R 544	5322 116 50621	536	1	MR25	METAL FILM
R 546	5322 116 50484	4,64K	1	MR25	METAL FILM
R 547	5322 116 54469	100	1	MR25	METAL FILM
R 552	5322 116 54426	121	1	MR25	METAL FILM
R 601	5322 116 50571	715	1	MR25	METAL FILM
R 602	5322 116 54442	51,1	1	MR25	METAL FILM
R 603	5322 116 50669	205	1	MR25	METAL FILM
R 604	5322 116 54448	59	1	MR25	METAL FILM
R 605	5322 116 54448	59	1	MR25	METAL FILM
R 606	5322 116 50729	4,22K	1	MR25	METAL FILM
R 607	5322 116 54469	100	1	MR25	METAL FILM
R 608	5322 116 50675	2,26K	1	MR25	METAL FILM
R 609	5322 116 54442	51,1	1	MR25	METAL FILM
R 611	5322 116 50571	715	1	MR25	METAL FILM
R 612	5322 116 50669	205	1	MR25	METAL FILM
R 613	5322 116 54448	59	1	MR25	METAL FILM
R 614	5322 116 54012	6,81K	1	MR25	METAL FILM
R 615	5322 116 54448	59	1	MR25	METAL FILM
R 616	5322 116 50484	4,64K	1	MR25	METAL FILM
R 617	5322 116 54515	348	1	MR25	METAL FILM
R 618	5322 116 54484	140	1	MR25	METAL FILM
R 619	5322 116 54558	8,25K	1	MR25	METAL FILM
R 621	5322 116 54469	100	1	MR25	METAL FILM
R 622	5322 116 54562	1,4K	1	MR25	METAL FILM
R 623	5322 116 54462	82,5	1	MR25	METAL FILM
R 624	5322 116 54484	140	1	MR25	METAL FILM
R 626	5322 116 54515	348	1	MR25	METAL FILM

R 627	5322 116 50484	4,64K	1	MR25	METAL FILM
R 628	5322 116 54012	6,81K	1	MR25	METAL FILM
R 629	5322 116 54549	1K	1	MR25	METAL FILM
R 631	5322 116 54511	316	1	MR25	METAL FILM
R 632	5322 116 50636	2,74K	1	MR25	METAL FILM
R 634	5322 101 14066	10K	20	0.5W	TRIMMING POTM
R 636	5322 101 14067	4,7K	20	0.5W	TRIMMING POTM
R 637	5322 116 54469	100	1	MR25	METAL FILM
R 639	5322 116 50452	10	1	MR25	METAL FILM
R 640	5322 116 54619	10K	1	MR25	METAL FILM
R 641	5322 116 50452	10	1	MR25	METAL FILM
R 642	5322 116 54619	10K	1	MR25	METAL FILM
R 643	5322 116 50678	20,5	1	MR25	METAL FILM
R 644	5322 116 50678	20,5	1	MR25	METAL FILM
R 646	5322 101 14066	10K	20	0.5W	TRIMMING POTM
R 647	5322 116 50636	2,74K	1	MR25	METAL FILM
R 649	4822 116 30018	1,3K	10	1W	NTC
R 652	5322 116 50672	51,1K	1	MR25	METAL FILM
R 653	5322 116 54648	24,9K	1	MR25	METAL FILM
R 654	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 655	5322 116 50664	2,05K	1	MR25	METAL FILM
R 656	5322 116 50664	2,05K	1	MR25	METAL FILM
R 657	5322 116 54469	100	1	MR25	METAL FILM
R 658	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 659	5322 116 50766	147	1	MR25	METAL FILM
R 660	5322 116 50766	147	1	MR25	METAL FILM
R 661	5322 116 54469	100	1	MR25	METAL FILM
R 701	5322 116 54442	51,1	1	MR25	METAL FILM
R 702	5322 116 54408	909K	1	MR30	METAL FILM
R 703	5322 116 54701	110K	1	MR25	METAL FILM
R 704	5322 116 54508	301	1	MR25	METAL FILM
R 706	5322 116 54335	750K	1	MR30	METAL FILM
R 707	5322 116 54549	1K	1	MR25	METAL FILM
R 708	5322 116 54549	1K	1	MR25	METAL FILM
R 709	5322 116 54734	249K	1	MR25	METAL FILM
R 711	4822 110 63214	10M	10	CR25	CARBON
R 712	5322 116 50527	33,2	1	MR25	METAL FILM
R 713	5322 116 54012	6,81K	1	MR25	METAL FILM
R 714	5322 116 54648	24,9K	1	MR25	METAL FILM
R 716	5322 116 50572	12,1K	1	MR25	METAL FILM
R 717	5322 116 54696	100K	1	MR25	METAL FILM
R 718	5322 116 54648	24,9K	1	MR25	METAL FILM
R 719	5322 116 54012	6,81K	1	MR25	METAL FILM
R 721	5322 116 50572	12,1K	1	MR25	METAL FILM
R 722	5322 116 54648	24,9K	1	MR25	METAL FILM
R 723	5322 116 54012	6,81K	1	MR25	METAL FILM
R 724	5322 116 54547	953	1	MR25	METAL FILM
R 726	5322 116 54469	100	1	MR25	METAL FILM
R 727	5322 116 54557	1,21K	1	MR25	METAL FILM
R 728	5322 116 54595	5,11K	1	MR25	METAL FILM
R 729	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 730	5322 116 54525	511	1	MR25	METAL FILM
R 731	5322 116 54723	187K	1	MR25	METAL FILM
R 732	5322 116 54605	6,98K	1	MR25	METAL FILM
R 733	5322 116 50581	2,49K	1	MR25	METAL FILM
R 734	5322 116 54685	71,5K	1	MR25	METAL FILM
R 735	5322 116 54595	5,11K	1	MR25	METAL FILM
R 736	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 738	5322 116 54496	200	1	MR25	METAL FILM
R 741	5322 116 54529	619	1	MR25	METAL FILM
R 742	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 800	5322 116 54469	100	1	MR25	METAL FILM
R 801	5322 116 54585	3,48K	1	MR25	METAL FILM
R 802	5322 116 54558	8,25K	1	MR25	METAL FILM
R 803	5322 116 54511	316	1	MR25	METAL FILM
R 804	5322 116 50527	33,2	1	MR25	METAL FILM
R 805	5322 116 50492	46,4	1	MR25	METAL FILM
R 806	5322 116 50492	46,4	1	MR25	METAL FILM
R 807	5322 116 54469	100	1	MR25	METAL FILM
R 808	5322 116 54536	750	1	MR25	METAL FILM

R 809	5322 116 54469	100	1	MR25	METAL FILM	
R 810	5322 116 50492	46,4	1	MR25	METAL FILM	
R 811	5322 116 54525	511	1	MR25	METAL FILM	
R 812	5322 116 54469	100	1	MR25	METAL FILM	
R 813	5322 116 54541	825	1	MR25	METAL FILM	
R 814	5322 116 54536	750	1	MR25	METAL FILM	
R 815	5322 116 50556	4,42K	1	MR25	METAL FILM	
R 816	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 817	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 818	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 819	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 820	5322 116 50527	33,2	1	MR25	METAL FILM	
R 821	5322 116 54534	681	1	MR25	METAL FILM	
R 822	5322 116 54469	100	1	MR25	METAL FILM	
R 823	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 824	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 826	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 827	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 828	5322 116 54469	100	1	MR25	METAL FILM	
R 829	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 831	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 832	5322 116 54442	51,1	1	MR25	METAL FILM	
R 833	5322 116 54442	51,1	1	MR25	METAL FILM	
R 834	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 835	5322 116 50491	22,6	1	MR25	METAL FILM	
R 836	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 837	5322 116 54469	100	1	MR25	METAL FILM	
R 838	5322 116 54469	100	1	MR25	METAL FILM	
R 839	5322 116 54506	287	1	MR25	METAL FILM	
R 841	5322 116 54536	750	1	MR25	METAL FILM	
R 842	5322 116 50491	22,6	1	MR25	METAL FILM	
R 843	5322 116 50491	22,6	1	MR25	METAL FILM	
R 844	5322 116 50536	464	1	MR25	METAL FILM	
R 846	5322 116 54557	1,21K	1	MR25	METAL FILM	
R 847	5322 116 54532	649	1	MR25	METAL FILM	
R 848	5322 116 54532	649	1	MR25	METAL FILM	
R 849	5322 116 54469	100	1	MR25	METAL FILM	
R 851	5322 116 54525	511	1	MR25	METAL FILM	
R 852	5322 100 10112	1K	20	0,5W	TRIMMING POTM	
R 853	5322 116 54592	4,02K	1	MR25	METAL FILM	
R 854	5322 116 54466	90,9	1	MR25	METAL FILM	
R 855	5322 116 50586	1,54K	1	MR25	METAL FILM	
R 857	5322 116 54534	681	1	MR25	METAL FILM	
R 858	5322 116 50555	1,27K	1	MR25	METAL FILM	
R 860	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 861	5322 116 54466	90,9	1	MR25	METAL FILM	
R 862	5322 116 54504	274	1	MR25	METAL FILM	
R 863	5322 116 50593	16,2K	1	MR25	METAL FILM	
R 864	5322 116 54511	316	1	MR25	METAL FILM	
R 865	5322 116 50491	22,6	1	MR25	METAL FILM	
R 866	5322 116 54511	316	1	MR25	METAL FILM	
R 867	5322 116 50593	16,2K	1	MR25	METAL FILM	
R 868	5322 116 54549	1K	1	MR25	METAL FILM	
R 869	5322 116 54619	10K	1	MR25	METAL FILM	
R 870	5322 116 50491	22,6	1	MR25	METAL FILM	
R 871	5322 116 54549	1K	1	MR25	METAL FILM	
R 872	5322 116 54192	5,11	1	MR25	METAL FILM	
R 873	5322 116 50491	22,6	1	MR25	METAL FILM	
R 874	5322 116 50669	205	1	MR25	METAL FILM	
R 876	5322 116 54511	316	1	MR25	METAL FILM	
R 877	5322 116 54511	316	1	MR25	METAL FILM	
R 878	5322 116 54513	332	1	MR25	METAL FILM	
R 879	5322 116 54513	332	1	MR25	METAL FILM	
R 900	5322 116 54567	1,69K	1	MR25	METAL FILM	
R 901	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 902	5322 116 54549	1K	1	MR25	METAL FILM	
R 903	5322 116 50561	590	1	MR25	METAL FILM	
R 904	5322 116 50527	33,2	1	MR25	METAL FILM	
R 905	5322 116 54508	301	1	MR25	METAL FILM	
R 906	5322 116 50536	464	1	MR25	METAL FILM	

R 907	5322 116 50536	464	1	MR25	METAL FILM	
R 908	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 909	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 910	5322 116 54606	7,15K	1	MR25	METAL FILM	
R 911	5322 100 10141	10K	20	0.75W	TRIMMING POTM	
R 912	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 913	5322 100 10141	10K	20	0.75W	TRIMMING POTM	
R 914	5322 116 54536	750	1	MR25	METAL FILM	
R 916	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 917	5322 116 54619	10K	1	MR25	METAL FILM	
R 918	5322 116 54589	3,83K	1	MR25	METAL FILM	
R 919	5322 116 50527	33,2	1	MR25	METAL FILM	
R 920	5322 116 54508	301	1	MR25	METAL FILM	
R 921	5322 116 50572	12,1K	1	MR25	METAL FILM	
R 922	5322 116 50583	5,9K	1	MR25	METAL FILM	
R 923	5322 116 50527	33,2	1	MR25	METAL FILM	
R 924	5322 116 50527	33,2	1	MR25	METAL FILM	
R 926	5322 116 54249	487	0,25	MR24C	METAL FILM	
R 927	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 928	5322 116 54549	1K	1	MR25	METAL FILM	
R 929	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 931	5322 116 54549	1K	1	MR25	METAL FILM	
R 932	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 933	5322 116 54549	1K	1	MR25	METAL FILM	
R 934	5322 116 50483	38,3K	1	MR25	METAL FILM	
R 936	5322 116 54619	10K	1	MR25	METAL FILM	
R 937	5322 116 54619	10K	1	MR25	METAL FILM	
R 938	4822 110 63207	5,6M	10	CR25	CARBON	
R 939	5322 116 54619	10K	1	MR25	METAL FILM	
R 940	5322 116 54513	332	1	MR25	METAL FILM	
R 941	5322 116 54192	5,11	1	MR25	METAL FILM	
R 942	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 943	5322 116 54455	68,1	1	MR25	METAL FILM	
R 944	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 945	5322 116 50527	33,2	1	MR25	METAL FILM	
R 946	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 947	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 948	5322 116 50728	1,87K	1	MR25	METAL FILM	
R 949	5322 116 54466	90,9	1	MR25	METAL FILM	
R 950	5322 116 54525	511	1	MR25	METAL FILM	
R 951	5322 116 54442	51,1	1	MR25	METAL FILM	
R 952	5322 116 54504	274	1	MR25	METAL FILM	
R 953	5322 116 54469	100	1	MR25	METAL FILM	
R 954	5322 116 54504	274	1	MR25	METAL FILM	
R 955	5322 116 54442	51,1	1	MR25	METAL FILM	
R 956	5322 116 54536	750	1	MR25	METAL FILM	
R 957	5322 116 50491	22,6	1	MR25	METAL FILM	
R 958	5322 116 54536	750	1	MR25	METAL FILM	
R 959	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 960	5322 116 54558	8,25K	1	MR25	METAL FILM	
R 961	5322 116 54619	10K	1	MR25	METAL FILM	
R 962	5322 116 54549	1K	1	MR25	METAL FILM	
R 963	5322 116 50669	205	1	MR25	METAL FILM	
R 964	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 965	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 966	5322 116 54009	562	1	MR25	METAL FILM	
R 967	5322 116 54504	274	1	MR25	METAL FILM	
R 968	5322 116 54504	274	1	MR25	METAL FILM	
R 969	5322 116 54469	100	1	MR25	METAL FILM	
R 970	5322 116 54619	10K	1	MR25	METAL FILM	
R 971	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 972	5322 116 54619	10K	1	MR25	METAL FILM	
R 973	5322 116 50536	464	1	MR25	METAL FILM	
R 974	5322 116 50593	16,2K	1	MR25	METAL FILM	
R 975	5322 116 54469	100	1	MR25	METAL FILM	
R 976	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 977	5322 116 50479	15,4K	1	MR25	METAL FILM	
R 978	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 979	5322 116 54549	1K	1	MR25	METAL FILM	
R 980	5322 116 54589	3,83K	1	MR25	METAL FILM	

R 981	5322 116 54549	1K	1	MR25	METAL FILM	
R 982	5322 116 54549	1K	1	MR25	METAL FILM	
R 983	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 984	5322 116 54519	402	1	MR25	METAL FILM	
R 985	5322 116 55315	619K	1	MR25	METAL FILM	
R 986	5322 116 50527	33,2	1	MR25	METAL FILM	
R 987	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 992	5322 116 50555	1,27K	1	MR25	METAL FILM	
R 993	5322 116 54549	1K	1	MR25	METAL FILM	
R 994	5322 116 50767	2,15K	1	MR25	METAL FILM	
R 995	5322 116 54508	301	1	MR25	METAL FILM	
R 996	5322 116 54508	301	1	MR25	METAL FILM	
R 997	5322 116 54442	51,1	1	MR25	METAL FILM	
R 998	5322 116 54619	10K	1	MR25	METAL FILM	
R 1001	5322 116 54877	402	0,25	MR24C	METAL FILM	
R 1002	5322 116 54902	876K	0,25	MR54C	METAL FILM	
R 1003	5322 116 54901	887K	0,25	MR54C	METAL FILM	
R 1004	5322 116 54896	354K	0,25	MR34C	METAL FILM	
R 1006	5322 116 54899	176K	0,25	MR34C	METAL FILM	
R 1007	5322 116 54897	87,6K	0,25	MR24C	METAL FILM	
R 1008	5322 116 54895	34,6K	0,25	MR24C	METAL FILM	
R 1009	5322 116 54894	16,8K	0,25	MR24C	METAL FILM	
R 1011	5322 116 55161	7,96K	0,25	MR24C	METAL FILM	
R 1012	5322 116 50784	2,67K	0,25	MR24C	METAL FILM	
R 1013	5322 116 54898	887	0,25	MR24C	METAL FILM	
R 1014	5322 116 54504	274	1	MR25	METAL FILM	
R 1101	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1102	5322 116 54335	750K	1	MR30	METAL FILM	
R 1103	5322 116 54549	1K	1	MR25	METAL FILM	
R 1104	5322 116 54549	1K	1	MR25	METAL FILM	
R 1106	5322 116 54734	249K	1	MR25	METAL FILM	
R 1107	4822 110 63214	10M	10	CR25	CARBON	
R 1108	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 1109	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1111	5322 116 54012	6,81K	1	MR25	METAL FILM	
R 1112	5322 116 54648	24,9K	1	MR25	METAL FILM	
R 1113	5322 116 54552	1,05K	1	MR25	METAL FILM	
R 1114	5322 116 54723	187K	1	MR25	METAL FILM	
R 1116	5322 116 54558	8,25K	1	MR25	METAL FILM	
R 1117	5322 116 54685	71,5K	1	MR25	METAL FILM	
R 1118	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1200	5322 116 54469	100	1	MR25	METAL FILM	
R 1201	5322 116 54585	3,48K	1	MR25	METAL FILM	
R 1202	5322 116 54558	8,25K	1	MR25	METAL FILM	
R 1203	5322 116 54511	316	1	MR25	METAL FILM	
R 1204	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1205	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1206	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1207	5322 116 54469	100	1	MR25	METAL FILM	
R 1208	5322 116 54536	750	1	MR25	METAL FILM	
R 1209	5322 116 54469	100	1	MR25	METAL FILM	
R 1211	5322 116 54525	511	1	MR25	METAL FILM	
R 1212	5322 116 50491	22,6	1	MR25	METAL FILM	
R 1214	5322 116 54536	750	1	MR25	METAL FILM	
R 1216	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 1217	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1218	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1219	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 1221	5322 116 54534	681	1	MR25	METAL FILM	
R 1222	5322 116 54469	100	1	MR25	METAL FILM	
R 1223	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 1224	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 1226	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1227	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1228	5322 116 54469	100	1	MR25	METAL FILM	
R 1229	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 1231	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1232	5322 116 54442	51,1	1	MR25	METAL FILM	
R 1233	5322 116 54442	51,1	1	MR25	METAL FILM	
R 1234	5322 116 50635	1,47K	1	MR25	METAL FILM	

R 1235	5322 116 50491	22,6	1	MR25	METAL FILM
R 1236	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1237	5322 116 54469	100	1	MR25	METAL FILM
R 1239	5322 116 54506	287	1	MR25	METAL FILM
R 1241	5322 116 54536	750	1	MR25	METAL FILM
R 1242	5322 116 51047	13,3	1	MR25	METAL FILM
R 1243	5322 116 51047	13,3	1	MR25	METAL FILM
R 1244	5322 116 54536	750	1	MR25	METAL FILM
R 1246	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1247	5322 116 54532	649	1	MR25	METAL FILM
R 1248	5322 116 54532	649	1	MR25	METAL FILM
R 1254	5322 116 50569	95,3	1	MR25	METAL FILM
R 1256	5322 116 54532	649	1	MR25	METAL FILM
R 1257	5322 116 54532	649	1	MR25	METAL FILM
R 1258	5322 116 54532	649	1	MR25	METAL FILM
R 1259	5322 116 54532	649	1	MR25	METAL FILM
R 1261	5322 116 54466	90,9	1	MR25	METAL FILM
R 1262	5322 116 54504	274	1	MR25	METAL FILM
R 1263	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1264	5322 116 54511	316	1	MR25	METAL FILM
R 1265	5322 116 50491	22,6	1	MR25	METAL FILM
R 1266	5322 116 54511	316	1	MR25	METAL FILM
R 1267	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1268	5322 116 54549	1K	1	MR25	METAL FILM
R 1269	5322 116 54619	10K	1	MR25	METAL FILM
R 1270	5322 116 50491	22,6	1	MR25	METAL FILM
R 1272	5322 116 54192	5,11	1	MR25	METAL FILM
R 1273	5322 116 50491	22,6	1	MR25	METAL FILM
R 1300	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1301	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1303	5322 116 54536	750	1	MR25	METAL FILM
R 1304	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1305	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1306	5322 116 54504	274	1	MR25	METAL FILM
R 1307	5322 116 54504	274	1	MR25	METAL FILM
R 1308	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1309	5322 116 50536	464	1	MR25	METAL FILM
R 1310	5322 116 54619	10K	1	MR25	METAL FILM
R 1311	5322 116 54469	100	1	MR25	METAL FILM
R 1312	5322 116 50536	464	1	MR25	METAL FILM
R 1313	5322 116 54549	1K	1	MR25	METAL FILM
R 1314	5322 116 50527	33,2	1	MR25	METAL FILM
R 1317	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1318	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1319	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1320	5322 116 54619	10K	1	MR25	METAL FILM
R 1321	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1322	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1323	5322 116 54536	750	1	MR25	METAL FILM
R 1324	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1326	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1327	5322 116 54589	3,83K	1	MR25	METAL FILM
R 1328	5322 116 54619	10K	1	MR25	METAL FILM
R 1329	5322 116 50527	33,2	1	MR25	METAL FILM
R 1331	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1332	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1333	5322 116 50527	33,2	1	MR25	METAL FILM
R 1334	5322 116 50527	33,2	1	MR25	METAL FILM
R 1335	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1336	5322 116 54898	887	0,25	MR24C	METAL FILM
R 1337	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1338	5322 116 54549	1K	1	MR25	METAL FILM
R 1339	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1341	5322 116 54549	1K	1	MR25	METAL FILM
R 1342	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1343	5322 116 54549	1K	1	MR25	METAL FILM
R 1344	5322 116 50954	38,3	1	MR25	METAL FILM
R 1346	5322 116 54619	10K	1	MR25	METAL FILM
R 1347	5322 116 54455	68,1	1	MR25	METAL FILM
R 1348	5322 116 50482	33,2K	1	MR25	METAL FILM

R 1349	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 1350	5322 116 54513	332	1	MR25	METAL FILM	
R 1351	4822 110 63207	5,6M	10	CR25	CARBON	
R 1352	5322 116 54442	51,1	1	MR25	METAL FILM	
R 1353	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 1354	5322 116 54619	10K	1	MR25	METAL FILM	
R 1355	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1356	5322 116 54619	10K	1	MR25	METAL FILM	
R 1357	5322 116 50479	15,4K	1	MR25	METAL FILM	
R 1358	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1359	5322 116 54504	274	1	MR25	METAL FILM	
R 1360	5322 116 50555	1,27K	1	MR25	METAL FILM	
R 1361	5322 116 54504	274	1	MR25	METAL FILM	
R 1362	5322 116 54536	750	1	MR25	METAL FILM	
R 1363	5322 116 50484	4,64K	1	MR25	METAL FILM	
R 1364	5322 116 54469	100	1	MR25	METAL FILM	
R 1365	5322 116 54549	1K	1	MR25	METAL FILM	
R 1366	5322 116 54561	1,33K	1	MR25	METAL FILM	
R 1367	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1368	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1369	5322 116 50415	1,15K	1	MR25	METAL FILM	
R 1370	5322 116 54549	1K	1	MR25	METAL FILM	
R 1371	5322 116 54469	100	1	MR25	METAL FILM	
R 1372	5322 116 54469	100	1	MR25	METAL FILM	
R 1373	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1374	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1376	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 1377	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1378	5322 116 50479	15,4K	1	MR25	METAL FILM	
R 1379	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1381	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1382	5322 116 54619	10K	1	MR25	METAL FILM	
R 1383	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 1384	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1386	5322 116 54508	301	1	MR25	METAL FILM	
R 1387	5322 116 50561	590	1	MR25	METAL FILM	
R 1388	5322 116 54508	301	1	MR25	METAL FILM	
R 1389	5322 116 54545	909	1	MR25	METAL FILM	
R 1391	5322 116 54545	909	1	MR25	METAL FILM	
R 1392	5322 116 50635	1,47K	1	MR25	METAL FILM	
R 1393	5322 116 54536	750	1	MR25	METAL FILM	
R 1394	5322 116 54549	1K	1	MR25	METAL FILM	
R 1396	5322 116 54508	301	1	MR25	METAL FILM	
R 1397	5322 116 54508	301	1	MR25	METAL FILM	
R 1398	5322 116 50767	2,15K	1	MR25	METAL FILM	
R 1401	5322 116 54901	887K	0,25	MR54C	METAL FILM	
R 1402	5322 116 54896	354K	0,25	MR34C	METAL FILM	
R 1403	5322 116 54899	176K	0,25	MR34C	METAL FILM	
R 1404	5322 116 54897	87,6K	0,25	MR24C	METAL FILM	
R 1406	5322 116 54895	34,6K	0,25	MR24C	METAL FILM	
R 1407	5322 116 54894	16,8K	0,25	MR24C	METAL FILM	
R 1408	5322 116 55161	7,96K	0,25	MR24C	METAL FILM	
R 1409	5322 116 50784	2,67K	0,25	MR24C	METAL FILM	
R 1411	5322 116 54898	887	0,25	MR24C	METAL FILM	
R 1501	5322 116 54549	1K	1	MR25	METAL FILM	
R 1502	5322 116 54619	10K	1	MR25	METAL FILM	
R 1503	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1504	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 1506	5322 116 54619	10K	1	MR25	METAL FILM	
R 1507	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1508	5322 116 54519	402	1	MR25	METAL FILM	
R 1509	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1511	5322 116 54519	402	1	MR25	METAL FILM	
R 1512	5322 116 54549	1K	1	MR25	METAL FILM	
R 1513	5322 116 54549	1K	1	MR25	METAL FILM	
R 1514	5322 116 54619	10K	1	MR25	METAL FILM	
R 1515	5322 116 50536	464	1	MR25	METAL FILM	
R 1516	5322 116 54619	10K	1	MR25	METAL FILM	
R 1517	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1518	5322 116 50482	33,2K	1	MR25	METAL FILM	

R 1519	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1520	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1521	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1522	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1524	5322 116 54613	8,66K	1	MR25	METAL FILM
R 1525	5322 116 50492	46,4	1	MR25	METAL FILM
R 1526	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1527	5322 116 50527	33,2	1	MR25	METAL FILM
R 1528	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1529	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1531	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1532	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1533	5322 116 54619	10K	1	MR25	METAL FILM
R 1534	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1535	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1536	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1537	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1538	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1539	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1541	5322 116 54469	100	1	MR25	METAL FILM
R 1542	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1543	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1551	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1552	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1553	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1554	5322 116 54513	332	1	MR25	METAL FILM
R 1556	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1557	5322 116 54513	332	1	MR25	METAL FILM
R 1558	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1559	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1561	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1562	5322 116 54513	332	1	MR25	METAL FILM
R 1563	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1564	5322 116 50578	78,7	1	MR25	METAL FILM
R 1566	5322 116 54513	332	1	MR25	METAL FILM
R 1567	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1568	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1569	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1570	5322 116 54469	100	1	MR25	METAL FILM
R 1571	5322 116 54513	332	1	MR25	METAL FILM
R 1572	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1573	5322 116 50669	205	1	MR25	METAL FILM
R 1574	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1576	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1577	5322 116 54513	332	1	MR25	METAL FILM
R 1578	5322 116 50578	78,7	1	MR25	METAL FILM
R 1579	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1581	5322 116 54513	332	1	MR25	METAL FILM
R 1601	5322 116 54534	681	1	MR25	METAL FILM
R 1602	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1603	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1604	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1606	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1607	5322 116 54549	1K	1	MR25	METAL FILM
R 1608	5322 116 54637	17,8K	1	MR25	METAL FILM
R 1609	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1611	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1612	5322 116 54549	1K	1	MR25	METAL FILM
R 1613	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1614	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1616	5322 116 54513	332	1	MR25	METAL FILM
R 1617	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1618	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1619	5322 116 54549	1K	1	MR25	METAL FILM
R 1621	5322 116 54549	1K	1	MR25	METAL FILM
R 1622	5322 116 54469	100	1	MR25	METAL FILM
R 1623	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1624	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1626	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1627	5322 116 54469	100	1	MR25	METAL FILM

R 1628	5322 116 54469	100	1	MR25	METAL FILM	
R 1629	5322 116 54469	100	1	MR25	METAL FILM	
R 1631	5322 116 54469	100	1	MR25	METAL FILM	
R 1632	5322 116 54469	100	1	MR25	METAL FILM	
R 1633	5322 116 54469	100	1	MR25	METAL FILM	
R 1651	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 1652	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 1653	5322 116 54585	3,48K	1	MR25	METAL FILM	
R 1654	5322 116 54513	332	1	MR25	METAL FILM	
R 1656	5322 116 54683	68,1K	1	MR25	METAL FILM	
R 1657	5322 116 54513	332	1	MR25	METAL FILM	
R 1658	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 1659	5322 116 50608	6,19K	1	MR25	METAL FILM	
R 1660	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1661	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 1662	5322 116 54513	332	1	MR25	METAL FILM	
R 1663	5322 116 54513	332	1	MR25	METAL FILM	
R 1664	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 1666	5322 116 51052	42,2	1	MR25	METAL FILM	
R 1667	5322 116 50664	2,05K	1	MR25	METAL FILM	
R 1668	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 1669	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1671	5322 116 54513	332	1	MR25	METAL FILM	
R 1672	5322 116 54683	68,1K	1	MR25	METAL FILM	
R 1673	5322 116 54484	140	1	MR25	METAL FILM	
R 1674	5322 116 51052	42,2	1	MR25	METAL FILM	
R 1675	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1676	5322 116 54484	140	1	MR25	METAL FILM	
R 1677	5322 116 50608	6,19K	1	MR25	METAL FILM	
R 1678	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 1679	5322 116 54513	332	1	MR25	METAL FILM	
R 1681	5322 116 54562	1,4K	1	MR25	METAL FILM	
R 1682	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1683	5322 116 50492	46,4	1	MR25	METAL FILM	
R 1701	5322 116 50508	487	1	MR25	METAL FILM	
R 1702	5322 116 54532	649	1	MR25	METAL FILM	
R 1703	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1704	5322 116 50417	162	1	MR25	METAL FILM	
R 1706	5322 100 10112	1K	20	0,5W	TRIMMING POTM	
R 1707	5322 116 54474	110	1	MR25	METAL FILM	
R 1708	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 1709	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1711	5322 116 50732	549	1	MR25	METAL FILM	
R 1712	5322 116 50732	549	1	MR25	METAL FILM	
R 1713	5322 116 50572	12,1K	1	MR25	METAL FILM	
R 1714	5322 116 54619	10K	1	MR25	METAL FILM	
R 1716	5322 116 54519	402	1	MR25	METAL FILM	
R 1718	5322 116 50572	12,1K	1	MR25	METAL FILM	
R 1719	5322 116 50491	22,6	1	MR25	METAL FILM	
R 1721	5322 116 50527	33,2	1	MR25	METAL FILM	
R 1722	5322 116 54689	82,5K	1	MR25	METAL FILM	
R 1723	5322 116 50479	15,4K	1	MR25	METAL FILM	
R 1724	5322 116 54696	100K	1	MR25	METAL FILM	
R 1726	5322 116 54641	19,6K	1	MR25	METAL FILM	
R 1727	5322 116 54651	26,1K	1	MR25	METAL FILM	
R 1728	5322 116 54532	649	1	MR25	METAL FILM	
R 1729	5322 116 54462	82,5	1	MR25	METAL FILM	
R 1731	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 1732	5322 116 54525	511	1	MR25	METAL FILM	
R 1733	5322 116 54549	1K	1	MR25	METAL FILM	
R 1734	5322 116 54519	402	1	MR25	METAL FILM	
R 1736	5322 116 54743	301K	1	MR25	METAL FILM	
R 1737	5322 101 14094	1M	20	0,5W	TRIMMING POTM	
R 1738	5322 116 54549	1K	1	MR25	METAL FILM	
R 1739	5322 116 54519	402	1	MR25	METAL FILM	
R 1741	5322 116 54743	301K	1	MR25	METAL FILM	
R 1742	5322 116 54525	511	1	MR25	METAL FILM	
R 1743	5322 116 54462	82,5	1	MR25	METAL FILM	
R 1744	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 1746	5322 116 54606	7,15K	1	MR25	METAL FILM	

R 1747	5322 116 54532	649	1	MR25	METAL FILM	
R 1748	5322 116 54619	10K	1	MR25	METAL FILM	
R 1749	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1751	5322 116 54696	100K	1	MR25	METAL FILM	
R 1752	5322 116 54696	100K	1	MR25	METAL FILM	
R 1801	5322 116 54743	301K	1	MR25	METAL FILM	
R 1802	5322 116 54743	301K	1	MR25	METAL FILM	
R 1803	4822 110 42187	1M	5	VR37	CARBON	
R 1804	4822 112 21121	3,3K	5	4.2W	WIRE-WOUND	
R 1806	5322 116 34051	750	1	7MW	NTC	
R 1807	5322 116 54701	110K	1	MR25	METAL FILM	
R 1808	5322 116 54701	110K	1	MR25	METAL FILM	
R 1809	5322 116 54701	110K	1	MR25	METAL FILM	
R 1811	5322 116 55337	1,62	1	MR25	METAL FILM	
R 1812	5322 116 54469	100	1	MR25	METAL FILM	
R 1813	5322 116 50491	22,6	1	MR25	METAL FILM	
R 1814	5322 116 54351	20	5	PR52	METAL FILM	
R 1816	5322 116 55205	2K	5	PR52	METAL FILM	
R 1817	4822 110 63214	10M	10	CR25	CARBON	
R 1818	4822 110 63214	10M	10	CR25	CARBON	
R 1819	5322 116 54648	24,9K	1	MR25	METAL FILM	
R 1822	5322 116 54571	1,96K	1	MR25	METAL FILM	
R 1823	5322 116 54696	100K	1	MR25	METAL FILM	
R 1824	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 1826	5322 100 10135	470	20	0.75W	TRIMMING POTM	
R 1827	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 1828	5322 116 50593	16,2K	1	MR25	METAL FILM	
R 1829	5322 116 50583	5,9K	1	MR25	METAL FILM	
R 1830	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 1831	5322 116 50583	5,9K	1	MR25	METAL FILM	
R 1832	5322 116 54005	3,32K	1	MR25	METAL FILM	
R 1833	5322 116 54012	6,81K	1	MR25	METAL FILM	
R 1834	5322 116 54499	249	1	MR25	METAL FILM	
R 1836	5322 116 50572	12,1K	1	MR25	METAL FILM	
R 1837	5322 116 54499	249	1	MR25	METAL FILM	
R 1838	5322 116 54484	140	1	MR25	METAL FILM	
R 1839	4822 110 63027	1	5	CR25	CARBON	
R 1846	5322 116 54734	249K	1	MR25	METAL FILM	
R 1847	5322 116 54734	249K	1	MR25	METAL FILM	
R 1848	4822 110 63187	1M	5	CR25	CARBON	
R 1849	5322 116 54619	10K	1	MR25	METAL FILM	
R 1851	5322 116 54683	68,1K	1	MR25	METAL FILM	
R 1852	5322 116 54734	249K	1	MR25	METAL FILM	
R 1853	5322 116 55258	511K	1	MR25	METAL FILM	
R 1854	4822 110 63187	1M	5	CR25	CARBON	
R 1856	5322 116 54561	1,33K	1	MR25	METAL FILM	
R 1857	5322 116 54561	1,33K	1	MR25	METAL FILM	
R 1858	5322 116 54549	1K	1	MR25	METAL FILM	
R 1861	5322 116 64078	20M	5	VR68	METAL OXIDE	
R 1862	4822 110 42187	1M	5	VR37	CARBON	
R 1901	5322 116 54462	82,5	1	MR25	METAL FILM	
R 1902	5322 116 54641	19,6K	1	MR25	METAL FILM	
R 1903	5322 116 50608	6,19K	1	MR25	METAL FILM	
R 1904	5322 116 54525	511	1	MR25	METAL FILM	
R 1906	5322 100 10141	10K	20	0.75W	TRIMMING POTM	
R 1907	5322 116 54536	750	1	MR25	METAL FILM	
R 1908	5322 116 54561	1,33K	1	MR25	METAL FILM	
R 1909	5322 116 50608	6,19K	1	MR25	METAL FILM	
R 1911	5322 116 54524	499	1	MR25	METAL FILM	
R 1912	5322 116 54469	100	1	MR25	METAL FILM	
R 1914	5322 116 54504	274	1	MR25	METAL FILM	
R 2000	5322 116 51052	42,2	1	MR25	METAL FILM	
R 2001	5322 116 51052	42,2	1	MR25	METAL FILM	
R 2002	5322 116 51052	42,2	1	MR25	METAL FILM	
R 2003	5322 116 54565	1,62K	1	MR25	METAL FILM	
R 2004	5322 116 54619	10K	1	MR25	METAL FILM	
R 2005	5322 116 50636	2,74K	1	MR25	METAL FILM	
R 2006	5322 116 50491	22,6	1	MR25	METAL FILM	
R 2007	5322 116 50414	2,87K	1	MR25	METAL FILM	
R 2008	5322 116 54592	4,02K	1	MR25	METAL FILM	

R 2009	5322 116 50443	12,7K	1	MR25	METAL FILM	
R 2010	5322 116 54643	20,5K	1	MR25	METAL FILM	
R 2011	5322 116 50536	464	1	MR25	METAL FILM	
R 2012	5322 116 54606	7,15K	1	MR25	METAL FILM	
R 2013	5322 116 54525	511	1	MR25	METAL FILM	
R 2014	5322 116 54567	1,69K	1	MR25	METAL FILM	
R 2015	5322 116 54606	7,15K	1	MR25	METAL FILM	
R 2016	5322 116 50636	2,74K	1	MR25	METAL FILM	
R 2017	5322 116 50481	22,6K	1	MR25	METAL FILM	
R 2018	5322 116 54619	10K	1	MR25	METAL FILM	
R 2020	5322 116 50558	18,7K	1	MR25	METAL FILM	
R 2021	5322 116 50675	2,26K	1	MR25	METAL FILM	
R 2022	5322 116 50669	205	1	MR25	METAL FILM	
R 2023	5322 116 54538	787	1	MR25	METAL FILM	
R 2024	5322 116 54585	3,48K	1	MR25	METAL FILM	
R 2026	5322 116 54547	953	1	MR25	METAL FILM	
R 2027	5322 116 54549	1K	1	MR25	METAL FILM	
R 2028	5322 116 54727	205K	1	MR25	METAL FILM	
R 2029	5322 116 54558	8,25K	1	MR25	METAL FILM	
R 2032	5322 116 54462	82,5	1	MR25	METAL FILM	
R 2033	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 2034	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 2036	5322 116 54643	20,5K	1	MR25	METAL FILM	
R 2037	5322 116 54513	332	1	MR25	METAL FILM	
R 2038	5322 116 50621	536	1	MR25	METAL FILM	
R 2041	5322 116 54549	1K	1	MR25	METAL FILM	
R 2042	5322 116 54727	205K	1	MR25	METAL FILM	
R 2043	5322 116 54558	8,25K	1	MR25	METAL FILM	
R 2046	5322 116 54462	82,5	1	MR25	METAL FILM	
R 2047	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 2048	5322 116 54643	20,5K	1	MR25	METAL FILM	
R 2049	5322 116 50581	2,49K	1	MR25	METAL FILM	
R 2051	5322 116 54513	332	1	MR25	METAL FILM	
R 2052	5322 116 50621	536	1	MR25	METAL FILM	
R 2053	5322 116 54712	147K	1	MR25	METAL FILM	
R 2054	5322 116 54595	5,11K	1	MR25	METAL FILM	
R 2055	5322 116 50491	22,6	1	MR25	METAL FILM	
R 2056	5322 116 50491	22,6	1	MR25	METAL FILM	
R 2057	5322 116 50457	215	1	MR25	METAL FILM	
R 2058	5322 116 54736	261K	1	MR25	METAL FILM	
R 2059	5322 116 50514	64,9K	1	MR25	METAL FILM	
R 2061	5322 116 50514	64,9K	1	MR25	METAL FILM	
R 2062	5322 116 54619	10K	1	MR25	METAL FILM	
R 2063	5322 116 50729	4,22K	1	MR25	METAL FILM	
R 2064	5322 100 10113	10K	20	0,5W	TRIMMING POTM	
R 2070	4822 110 63196	2,2M	10	CR25	CARBON	
R 2072	4822 110 63196	2,2M	10	CR25	CARBON	
R 2073	4822 110 63189	1,2M	10	CR25	CARBON	
R 2074	5322 116 54689	82,5K	1	MR25	METAL FILM	
R 2075	5322 116 54279	115K	1	MR25	METAL FILM	
R 2076	4822 110 42218	15M	5	VR37	CARBON	
R 2077	4822 110 42218	15M	5	VR37	CARBON	
R 2078	5322 116 64018	13M	5	VR37	METAL OXIDE	
R 2079	4822 110 42209	6,8M	5	VR37	CARBON	
R 2081	5322 116 54549	1K	1	MR25	METAL FILM	
R 2082	4822 110 63187	1M	5	CR25	CARBON	
R 2083	4822 110 63187	1M	5	CR25	CARBON	
R 2084	5322 116 54696	100K	1	MR25	METAL FILM	
R 2086	4822 110 42227	33M	5	VR37	CARBON	
R 2087	4822 110 42212	8,2M	5	VR37	CARBON	
R 2088	5322 116 50451	21,5K	1	MR25	METAL FILM	
R 2101	4822 110 63194	1,8M	10	CR25	CARBON	
R 2102	5322 101 14094	1M	20	0,5W	TRIMMING POTM	
R 2103	5322 101 14094	1M	20	0,5W	TRIMMING POTM	
R 2106	5322 116 54743	301K	1	MR25	METAL FILM	
R 2107	5322 116 54469	100	1	MR25	METAL FILM	
R 2113	5322 116 54549	1K	1	MR25	METAL FILM	
R 2116	5322 116 54549	1K	1	MR25	METAL FILM	
R 2117	5322 116 50482	33,2K	1	MR25	METAL FILM	
R 2118	5322 116 50491	22,6	1	MR25	METAL FILM	

R 2121	5322 116 54718	169K	1	MR25	METAL FILM
R 2122	5322 116 55284	681K	1	MR25	METAL FILM
R 2123	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 2124	5322 116 54469	100	1	MR25	METAL FILM
R 2127	5322 116 50491	22,6	1	MR25	METAL FILM
R 2128	5322 116 50491	22,6	1	MR25	METAL FILM
R 2129	5322 116 50491	22,6	1	MR25	METAL FILM
R 2131	5322 116 50491	22,6	1	MR25	METAL FILM
R 2132	5322 116 54279	115K	1	MR25	METAL FILM
R 2133	5322 116 54689	82,5K	1	MR25	METAL FILM
R 2134	4822 110 63189	1,2M	10	CR25	CARBON
R 2136	4822 110 63189	1,2M	10	CR25	CARBON
R 2137	4822 110 63189	1,2M	10	CR25	CARBON
R 2202	5322 111 94163	5X100K			RES. ARRAY
R 2203	5322 116 54696	100K	1	MR25	METAL FILM
R 2204	5322 116 54743	301K	1	MR25	METAL FILM
R 2207	4822 110 63187	1M	5	CR25	CARBON
R 2211	4822 110 63192	1,5M	10	CR25	CARBON
R 2213	5322 116 50452	10	1	MR25	METAL FILM
R 2216	5322 116 54696	100K	1	MR25	METAL FILM
R 2222	4822 110 63212	8,2M	10	CR25	CARBON
R 2223	4822 110 63205	4,7M	10	CR25	CARBON
R 2224	4822 110 63205	4,7M	10	CR25	CARBON
R 2226	5322 116 54696	100K	1	MR25	METAL FILM
R 2227	4822 110 63205	4,7M	10	CR25	CARBON
R 2228	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2229	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2232	5322 116 50452	10	1	MR25	METAL FILM
R 2233	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2237	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2238	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2239	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2241	5322 111 94163	5X100K			RES. ARRAY
R 2242	5322 111 94163	5X100K			RES. ARRAY
R 2243	5322 116 54696	100K	1	MR25	METAL FILM
R 2246	4822 110 63183	680K	5	CR25	CARBON
R 2247	5322 116 54469	100	1	MR25	METAL FILM
R 2248	5322 116 50509	4,87K	1	MR25	METAL FILM
R 2249	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2251	5322 116 50492	46,4	1	MR25	METAL FILM
R 2252	5322 116 50672	51,1K	1	MR25	METAL FILM
R 2253	5322 116 50608	6,19K	1	MR25	METAL FILM
R 2254	5322 116 54696	100K	1	MR25	METAL FILM
R 2257	5322 116 54619	10K	1	MR25	METAL FILM
R 2258	5322 116 50557	46,4K	1	MR25	METAL FILM
R 2259	5322 116 54635	16,9K	1	MR25	METAL FILM
R 2262	5322 116 54627	13,3K	1	MR25	METAL FILM
R 2263	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2267	5322 116 54696	100K	1	MR25	METAL FILM
R 2272	5322 116 54696	100K	1	MR25	METAL FILM
R 2274	5322 116 54696	100K	1	MR25	METAL FILM
R 2276	4822 110 63192	1,5M	10	CR25	CARBON
R 2277	5322 116 54696	100K	1	MR25	METAL FILM
R 2278	5322 116 50515	1,78K	1	MR25	METAL FILM
R 2284	5322 116 54469	100	1	MR25	METAL FILM
R 2287	5322 116 54529	619	1	MR25	METAL FILM
R 2288	4822 110 63183	680K	5	CR25	CARBON
R 2293	4822 110 63187	1M	5	CR25	CARBON
R 2294	5322 116 54602	6,34K	1	MR25	METAL FILM
R 2297	5322 116 50557	46,4K	1	MR25	METAL FILM
R 2298	5322 116 50731	10,5K	1	MR25	METAL FILM
R 2299	5322 116 50479	15,4K	1	MR25	METAL FILM
R 2302	4822 110 63192	1,5M	10	CR25	CARBON
R 2303	5322 116 54696	100K	1	MR25	METAL FILM
R 2304	5322 116 54696	100K	1	MR25	METAL FILM
R 2306	5322 111 94163	5X100K			RES. ARRAY
R 2309	5322 111 94163	5X100K			RES. ARRAY
R 2311	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2312	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2314	4822 110 63212	8,2M	10	CR25	CARBON

R 2401	5322 116 54595	5,11K	1	MR25	METAL FILM
R 2402	5322 116 54606	7,15K	1	MR25	METAL FILM
R 2403	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2404	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2406	5322 116 54011	5,62K	1	MR25	METAL FILM
R 2407	5322 116 54653	28,7K	1	MR25	METAL FILM
R 2408	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2409	5322 116 54685	71,5K	1	MR25	METAL FILM
R 2411	5322 116 54729	226K	1	MR25	METAL FILM
R 2412	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2413	5322 116 50558	18,7K	1	MR25	METAL FILM
R 2414	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2417	5322 116 54689	82,5K	1	MR25	METAL FILM
R 2418	5322 116 54012	6,81K	1	MR25	METAL FILM
R 2419	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2422	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2423	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2424	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2427	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2428	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2429	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2432	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2433	5322 116 50636	2,74K	1	MR25	METAL FILM
R 2439	5322 116 54011	5,62K	1	MR25	METAL FILM
R 2442	5322 116 54469	100	1	MR25	METAL FILM
R 2443	5322 116 54469	100	1	MR25	METAL FILM
R 2444	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2447	5322 116 54696	100K	1	MR25	METAL FILM
R 2448	5322 116 54469	100	1	MR25	METAL FILM
R 2449	5322 116 54469	100	1	MR25	METAL FILM
R 2452	5322 116 54469	100	1	MR25	METAL FILM
R 2453	5322 116 54469	100	1	MR25	METAL FILM
R 2454	5322 116 54708	133K	1	MR25	METAL FILM
R 2457	5322 116 50671	2,61K	1	MR25	METAL FILM
R 2462	5322 116 54704	121K	1	MR25	METAL FILM
R 2463	5322 116 54469	100	1	MR25	METAL FILM
R 2464	5322 116 54619	10K	1	MR25	METAL FILM
R 2466	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2467	5322 116 54689	82,5K	1	MR25	METAL FILM
R 2468	5322 116 54469	100	1	MR25	METAL FILM
R 2469	5322 116 54469	100	1	MR25	METAL FILM
R 2471	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2472	5322 116 54469	100	1	MR25	METAL FILM
R 2473	5322 116 54469	100	1	MR25	METAL FILM
R 2474	5322 116 54469	100	1	MR25	METAL FILM
R 2478	4822 110 53192	1,5M	10	CR37	CARBON
R 2479	5322 116 54469	100	1	MR25	METAL FILM
R 2482	4822 110 53192	1,5M	10	CR37	CARBON
R 2483	4822 110 53192	1,5M	10	CR37	CARBON
R 2484	5322 116 54011	5,62K	1	MR25	METAL FILM
R 2486	5322 116 54011	5,62K	1	MR25	METAL FILM
R 2487	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2488	5322 116 54665	40,2K	1	MR25	METAL FILM
R 2489	5322 116 54619	10K	1	MR25	METAL FILM
R 2491	5322 116 54469	100	1	MR25	METAL FILM
R 2492	5322 116 54469	100	1	MR25	METAL FILM
R 2493	5322 116 54469	100	1	MR25	METAL FILM
R 2494	4822 110 53192	1,5M	10	CR37	CARBON
R 2496	5322 116 50675	2,26K	1	MR25	METAL FILM
R 2497	5322 116 50731	10,5K	1	MR25	METAL FILM
R 2498	5322 116 54592	4,02K	1	MR25	METAL FILM
R 2499	5322 116 54592	4,02K	1	MR25	METAL FILM
R 2502	5322 116 50872	61,9K	1	MR25	METAL FILM
R 2503	5322 116 54469	100	1	MR25	METAL FILM
R 2504	5322 116 54469	100	1	MR25	METAL FILM
R 2507	5322 116 54469	100	1	MR25	METAL FILM
R 2508	5322 116 54469	100	1	MR25	METAL FILM
R 2509	5322 116 54469	100	1	MR25	METAL FILM
R 2512	5322 116 50559	27,4K	1	MR25	METAL FILM
R 2513	5322 116 54732	237K	1	MR25	METAL FILM

R 2514	5322 116 54469	100	1	MR25	METAL FILM
R 2515	5322 116 54696	100K	1	MR25	METAL FILM
R 2516	5322 116 54595	5,11K	1	MR25	METAL FILM
R 2517	5322 116 54469	100	1	MR25	METAL FILM
R 2518	5322 116 50557	46,4K	1	MR25	METAL FILM
R 2519	5322 116 54696	100K	1	MR25	METAL FILM
R 2521	5322 116 50572	12,1K	1	MR25	METAL FILM
R 2522	5322 116 54619	10K	1	MR25	METAL FILM
R 2523	5322 100 10142	100K	20	0.75W	TRIMMING POTM
R 2524	5322 116 54685	71,5K	1	MR25	METAL FILM
R 2526	5322 116 54655	30,1K	1	MR25	METAL FILM
R 2527	5322 116 54469	100	1	MR25	METAL FILM
R 2528	5322 116 54712	147K	1	MR25	METAL FILM
R 2529	5322 116 54712	147K	1	MR25	METAL FILM
R 2531	5322 116 50581	2,49K	1	MR25	METAL FILM
R 2532	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2533	5322 116 50572	12,1K	1	MR25	METAL FILM
R 2534	5322 116 54469	100	1	MR25	METAL FILM
R 2535	5322 116 54549	1K	1	MR25	METAL FILM
R 2536	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2537	5322 116 54469	100	1	MR25	METAL FILM
R 2538	5322 116 54702	133K	1	MR25	METAL FILM
R 2539	5322 116 54576	2,37K	1	MR25	METAL FILM
R 2541	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2542	5322 116 50572	12,1K	1	MR25	METAL FILM
R 2543	5322 116 54469	100	1	MR25	METAL FILM
R 2544	5322 116 50482	33,2K	1	MR25	METAL FILM
R 2545	5322 116 50559	27,4K	1	MR25	METAL FILM
R 2546	5322 116 50452	10	1	MR25	METAL FILM
R 2547	5322 116 50479	15,4K	1	MR25	METAL FILM
R 2548	5322 116 54694	90,9K	1	MR25	METAL FILM
R 2549	5322 100 10143	1K	20	0.75W	TRIMMING POTM
R 2551	4822 116 30041	4	20	1W	NTC
R 2562	5322 116 54549	1K	1	MR25	METAL FILM
R 2563	5322 116 54469	100	1	MR25	METAL FILM
R 2564	5322 116 54469	100	1	MR25	METAL FILM
R 2566	5322 116 50452	10	1	MR25	METAL FILM
R 2568	5322 116 50491	22,6	1	MR25	METAL FILM
R 2576	5322 116 50443	12,7K	1	MR25	METAL FILM
R 2577	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 2578	5322 116 54558	8,25K	1	MR25	METAL FILM

Item	Ordering number	Type/Description	
Semi conductors			
V 1	5322 131 24053	83L14GH55	PH
V 2	5322 130 34595	CQY24A-I	
V 3	5322 130 34595	CQY24A-I	
V 4	5322 130 34595	CQY24A-I	
V 5	5322 130 34595	CQY24A-I	
V 6	5322 130 34595	CQY24A-I	
V 7	5322 130 34595	CQY24A-I	
V 101	5322 130 34037	BAV45	
V 102	5322 130 44605	ON471	
V 103	5322 130 44459	BFT25R	
V 104	5322 130 44178	BFR92	
V 151	5322 130 34037	BAV45	
V 152	5322 130 44605	ON471	
V 153	5322 130 44458	BFT25	
V 154	5322 130 44606	BFR92R	
V 201	4822 130 30613	BAW62	
V 203	5322 130 44711	BFT92	PH
V 204	5322 130 44713	BFT92R	PH
V 205	4822 130 34047	BZX75-C1V4	
V 206	5322 130 34331	BAV70	
V 207	5322 130 34331	BAV70	
V 208	4822 130 30613	BAW62	
V 209	4822 130 30613	BAW62	
V 210	4822 130 30613	BAW62	
V 211	4822 130 30613	BAW62	
V 212	4822 130 44246	BC549C	
V 216	4822 130 44358	BC559B	
V 217	4822 130 30613	BAW62	
V 218	4822 130 30613	BAW62	
V 219	4822 130 44246	BC549C	
V 221	4822 130 30613	BAW62	
V 222	4822 130 30613	BAW62	
V 223	4822 130 30613	BAW62	
V 224	4822 130 30613	BAW62	
V 301	4822 130 30613	BAW62	
V 303	5322 130 44711	BFT92	PH
V 304	5322 130 44713	BFT92R	PH
V 305	4822 130 34047	BZX75-C1V4	
V 306	5322 130 34331	BAV70	
V 307	5322 130 34331	BAV70	
V 308	4822 130 30613	BAW62	
V 309	4822 130 30613	BAW62	
V 310	4822 130 30613	BAW62	
V 311	4822 130 30613	BAW62	
V 312	4822 130 44246	BC549C	
V 316	4822 130 44358	BC559B	
V 317	4822 130 30613	BAW62	
V 318	4822 130 30613	BAW62	
V 319	4822 130 44246	BC549C	
V 321	4822 130 30613	BAW62	
V 322	4822 130 30613	BAW62	
V 323	4822 130 30613	BAW62	
V 324	4822 130 30613	BAW62	
V 401	4822 130 44246	BC549C	
V 402	4822 130 34047	BZX75-C1V4	
V 403	4822 130 30613	BAW62	
V 404	4822 130 30613	BAW62	
V 406	4822 130 34047	BZX75-C1V4	
V 407	4822 130 44358	BC559B	
V 408	4822 130 44246	BC549C	
V 451	4822 130 44246	BC549C	
V 452	4822 130 34047	BZX75-C1V4	
V 453	4822 130 30613	BAW62	
V 454	4822 130 30613	BAW62	
V 456	4822 130 34047	BZX75-C1V4	
V 457	4822 130 44358	BC559B	
V 458	4822 130 44246	BC549C	
V 459	4822 130 44246	BC549C	

V 461	4822 130 30613	BAW62	
V 462	4822 130 30613	BAW62	
V 501	4822 130 44358	BC559B	
V 502	5322 130 44713	BFT92R	PH
V 503	4822 130 44358	BC559B	
V 504	5322 130 44711	BFT92	PH
V 505	5322 130 34302	BA280	PH
V 506	4822 130 44246	BC549C	
V 507	4822 130 30613	BAW62	
V 508	4822 130 30613	BAW62	
V 509	4822 130 30613	BAW62	
V 510	5322 130 34302	BA280	PH
V 511	4822 130 30613	BAW62	
V 601	5322 130 44713	BFT92R	PH
V 602	5322 130 44711	BFT92	PH
V 603	4822 130 44246	BC549C	
V 604	4822 130 30613	BAW62	
V 606	4822 130 44246	BC549C	
V 607	4822 130 44246	BC549C	
V 608	4822 130 44358	BC559B	
V 609	5322 130 34689	BBY31	
V 611	5322 130 34689	BBY31	
V 612	4822 130 30765	BZX75-C3V6	
V 613	5322 130 30772	BZX87-C5V6	
V 614	5322 130 30772	BZX87-C5V6	
V 701	5322 130 44476	BC264A	PH
V 702	4822 130 44358	BC559B	
V 703	4822 130 44358	BC559B	
V 704	4822 130 44358	BC559B	
V 705	4822 130 34049	BZX75-C2V1	
V 706	4822 130 44246	BC549C	
V 707	4822 130 30613	BAW62	
V 708	4822 130 30613	BAW62	
V 709	4822 130 30613	BAW62	
V 711	5322 130 40493	BFY90	
V 712	5322 130 40493	BFY90	
V 800	4822 130 30613	BAW62	
V 801	4822 130 44358	BC559B	
V 802	4822 130 44358	BC559B	
V 803	5322 130 44711	BFT92	PH
V 804	5322 130 44713	BFT92R	PH
V 805	4822 130 30613	BAW62	
V 806	5322 130 44178	BFR92	
V 807	4822 130 30613	BAW62	
V 808	4822 130 30613	BAW62	
V 809	4822 130 30613	BAW62	
V 811	4822 130 30613	BAW62	
V 812	4822 130 30613	BAW62	
V 813	4822 130 30613	BAW62	
V 814	5322 130 44396	BF324	
V 818	5322 130 44606	BFR92R	
V 819	5322 130 44178	BFR92	
V 820	5322 130 34337	BAV99	
V 821	5322 130 40832	BF183	PH
V 822	4822 130 30613	BAW62	
V 823	4822 130 30613	BAW62	
V 824	5322 130 40832	BF183	PH
V 826	4822 130 30613	BAW62	
V 827	4822 130 30613	BAW62	
V 828	4822 130 44246	BC549C	
V 901	4822 130 30613	BAW62	
V 902	4822 130 44246	BC549C	
V 903	5322 130 40417	BSX20	
V 904	4822 130 30613	BAW62	
V 906	5322 130 40417	BSX20	
V 907	5322 130 40417	BSX20	
V 908	4822 130 44246	BC549C	
V 909	4822 130 30613	BAW62	
V 910	4822 130 30613	BAW62	
V 911	4822 130 44246	BC549C	

V	912	4822	130	30613	BAW62
V	913	4822	130	44358	BC559B
V	914	4822	130	44358	BC559B
V	916	4822	130	44246	BC549C
V	917	4822	130	30613	BAW62
V	918	4822	130	44246	BC549C
V	919	4822	130	44246	BC549C
V	921	4822	130	30613	BAW62
V	922	4822	130	44246	BC549C
V	923	4822	130	44246	BC549C
V	924	4822	130	44358	BC559B
V	925	4822	130	30613	BAW62
V	926	4822	130	30613	BAW62
V	927	4822	130	30613	BAW62
V	928	5322	130	40417	BSX20
V	929	5322	130	44396	BF324
V	930	4822	130	30613	BAW62
V	931	4822	130	44358	BC559B
V	932	4822	130	30613	BAW62
V	933	4822	130	30613	BAW62
V	934	4822	130	44358	BC559B
V	935	4822	130	30613	BAW62
V	936	4822	130	44246	BC549C
V	937	4822	130	44246	BC549C
V	938	4822	130	30613	BAW62
V	939	4822	130	44358	BC559B
V	940	4822	130	30613	BAW62
V	941	4822	130	30613	BAW62
V	942	4822	130	30613	BAW62
V	943	4822	130	30613	BAW62
V	944	5322	130	44396	BF324
V	945	4822	130	44246	BC549C
V	946	4822	130	30613	BAW62
V	948	4822	130	44246	BC549C
V	949	4822	130	44246	BC549C
V	950	4822	130	30613	BAW62
V	951	4822	130	44246	BC549C
V	952	4822	130	44246	BC549C
V	953	4822	130	30613	BAW62
V	954	4822	130	44358	BC559B
V	956	4822	130	44246	BC549C
V	957	4822	130	30613	BAW62
V	958	4822	130	30613	BAW62
V	959	4822	130	44246	BC549C
V	960	4822	130	30613	BAW62
V	961	4822	130	44358	BC559B
V	962	4822	130	30613	BAW62
V	963	4822	130	30613	BAW62
V	964	4822	130	44246	BC549C
V	1101	5322	130	44476	BC264A PH
V	1102	4822	130	44358	BC559B
V	1103	4822	130	30613	BAW62
V	1104	5322	130	40493	BFY90
V	1200	4822	130	30613	BAW62
V	1201	4822	130	44358	BC559B
V	1203	5322	130	44711	BFT92 PH
V	1204	5322	130	44711	BFT92 PH
V	1206	5322	130	44606	BFR92R
V	1207	4822	130	30613	BAW62
V	1208	4822	130	30613	BAW62
V	1209	4822	130	30613	BAW62
V	1211	4822	130	30613	BAW62
V	1212	4822	130	30613	BAW62
V	1213	4822	130	30613	BAW62
V	1214	5322	130	44396	BF324
V	1215	4822	130	30613	BAW62
V	1216	5322	130	44178	BFR92
V	1217	5322	130	44606	BFR92R
V	1218	5322	130	44606	BFR92R
V	1219	5322	130	44178	BFR92

V	1220	4822	130	30613	BAW62
V	1221	5322	130	40832	BF183 PH
V	1222	4822	130	30613	BAW62
V	1223	4822	130	30613	BAW62
V	1224	5322	130	40832	BF183 PH
V	1226	4822	130	30613	BAW62
V	1227	4822	130	30613	BAW62
V	1228	4822	130	44246	BC549C
V	1300	4822	130	44246	BC549C
V	1301	4822	130	30613	BAW62
V	1302	4822	130	30613	BAW62
V	1303	4822	130	30613	BAW62
V	1304	5322	130	44396	BF324
V	1305	4822	130	30613	BAW62
V	1306	4822	130	30613	BAW62
V	1307	4822	130	44246	BC549C
V	1308	5322	130	40417	BSX20
V	1309	5322	130	40417	BSX20
V	1311	5322	130	40417	BSX20
V	1312	4822	130	44246	BC549C
V	1313	4822	130	30613	BAW62
V	1314	4822	130	44246	BC549C
V	1316	4822	130	30613	BAW62
V	1317	4822	130	44358	BC559B
V	1318	4822	130	44358	BC559B
V	1319	4822	130	44246	BC549C
V	1321	4822	130	30613	BAW62
V	1322	4822	130	44246	BC549C
V	1323	4822	130	44246	BC549C
V	1324	4822	130	30613	BAW62
V	1326	4822	130	44246	BC549C
V	1327	4822	130	44246	BC549C
V	1328	4822	130	44358	BC559B
V	1329	4822	130	30613	BAW62
V	1331	4822	130	30613	BAW62
V	1332	4822	130	30613	BAW62
V	1336	4822	130	44358	BC559B
V	1337	4822	130	30613	BAW62
V	1338	4822	130	30613	BAW62
V	1339	4822	130	44246	BC549C
V	1501	4822	130	44246	BC549C
V	1502	4822	130	44358	BC559B
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V	1504	4822	130	30613	BAW62
V	1506	4822	130	44358	BC559B
V	1507	4822	130	30613	BAW62
V	1508	4822	130	30613	BAW62
V	1509	4822	130	44246	BC549C
V	1511	4822	130	44358	BC559B
V	1512	4822	130	44358	BC559B
V	1513	4822	130	30613	BAW62
V	1514	4822	130	30613	BAW62
V	1515	4822	130	30613	BAW62
V	1516	4822	130	44358	BC559B
V	1517	4822	130	44358	BC559B
V	1518	4822	130	30613	BAW62
V	1519	4822	130	44246	BC549C
V	1520	4822	130	44246	BC549C
V	1521	4822	130	44358	BC559B
V	1522	4822	130	30613	BAW62
V	1523	5322	130	34119	BZX79-C8V2
V	1524	4822	130	44358	BC559B
V	1526	4822	130	30613	BAW62
V	1527	5322	130	44396	BF324
V	1528	4822	130	30613	BAW62
V	1529	4822	130	30613	BAW62
V	1551	4822	130	30613	BAW62
V	1552	4822	130	34167	BZX79-B6V2
V	1553	4822	130	30613	BAW62
V	1554	4822	130	30613	BAW62

V 1556	4822 130 30613	BAW62	
V 1557	4822 130 30613	BAW62	
V 1558	4822 130 30613	BAW62	
V 1559	4822 130 40645	BD135	
V 1561	4822 130 44358	BC559B	
V 1562	4822 130 40645	BD135	
V 1563	4822 130 30613	BAW62	
V 1564	4822 130 34167	BZX79-B6V2	
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V 1567	4822 130 40712	BD136	
V 1568	4822 130 40712	BD136	
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V 1602	5322 130 34605	BAX12A	
V 1651	4822 130 30613	BAW62	
V 1652	4822 130 34167	BZX79-B6V2	
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V 1654	4822 130 30613	BAW62	
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V 1657	4822 130 30613	BAW62	
V 1658	4822 130 30613	BAW62	
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V 1662	4822 130 40645	BD135	
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V 1664	4822 130 34167	BZX79-B6V2	
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V 1702	5322 130 40417	BSX20	
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V 1704	4822 130 44358	BC559B	
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V 1707	4822 130 41106	BF423	PH
V 1708	4822 130 41106	BF423	PH
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V 1716	4822 130 41106	BF423	PH
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V 1718	4822 130 41084	BF422	PH
V 1719	4822 130 34173	BZX79-C5V6	
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V 1803	5322 130 44718	BUX86	PH
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V 1806	4822 130 44508	BU208	PH
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V 1808	4822 130 31051	BY208-1000	PH
V 1809	4822 130 31051	BY208-1000	PH
V 1811	4822 130 31051	BY208-1000	PH
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V 1813	4822 130 34281	BZX79-C15	
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V 1817	4822 130 30839	BY206	
V 1818	4822 130 30839	BY206	
V 1819	4822 130 30839	BY206	
V 1826	4822 130 30817	BYX55-600	
V 1827	4822 130 30839	BY206	
V 1828	4822 130 30839	BY206	
V 1829	4822 130 30817	BYX55-600	
V 1831	4822 130 30817	BYX55-600	

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V 1833	4822 130 30817	BYX55-600	
V 1834	4822 130 30817	BYX55-600	
V 1836	4822 130 30839	BY206	
V 1837	4822 130 30839	BY206	
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V 1839	4822 130 30839	BY206	
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V 1844	4822 130 44246	BC549C	
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V 1852	5322 130 34594	BY409	
V 1853	5322 130 34594	BY409	
V 1854	5322 130 34594	BY409	
V 1876	4822 130 30839	BY206	
V 1877	4822 130 30839	BY206	
V 1878	4822 130 30839	BY206	
V 1879	4822 130 30839	BY206	
V 1881	4822 130 30839	BY206	
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V 1883	4822 130 30839	BY206	
V 1884	4822 130 30839	BY206	
V 1886	4822 130 30839	BY206	
V 1887	4822 130 30839	BY206	
V 1901	4822 130 34173	BZX79-C5V6	
V 2000	4822 130 44246	BC549C	
V 2001	4822 130 44358	BC559B	
V 2002	5322 130 40417	BSX20	
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V 2005	4822 130 34174	BZX79-C4V7	
V 2006	4822 130 30613	BAW62	
V 2007	5322 130 44396	BF324	
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V 2013	4822 130 41084	BF422	PH
V 2016	4822 130 41084	BF422	PH
V 2018	5322 130 44396	BF324	
V 2019	4822 130 34173	BZX79-C5V6	
V 2021	5322 130 40493	BFY90	
V 2023	4822 130 41106	BF423	PH
V 2026	4822 130 41084	BF422	PH
V 2028	4822 130 41084	BF422	PH
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V 2032	5322 130 40493	BFY90	
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V 2034	4822 130 30613	BAW62	
V 2036	5322 130 34605	BAX12	
V 2037	4822 130 41084	BF422	PH
V 2038	4822 130 44358	BC559B	
V 2039	4822 130 41106	BF423	PH
V 2040	4822 130 41106	BF423	PH
V 2041	4822 130 41106	BF423	PH
V 2042	4822 130 41106	BF423	PH
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V 2057	4822 130 44358	BC559B	
V 2058	4822 130 30195	BYX10	
V 2063	4822 130 44246	BC549C	
V 2064	4822 130 44358	BC559B	
V 2071	5322 130 34605	BAX12	
V 2072	5322 130 34605	BAX12	
V 2073	4822 130 41207	BD232	
V 2076	5322 130 34605	BAX12	
V 2077	5322 130 34605	BAX12	
V 2078	5322 130 44712	V103R2	SL
V 2081	5322 130 34594	BY409	
V 2082	5322 130 34594	BY409	
V 2083	5322 130 34594	BY409	

V	2201	4822	130	30613	BAW62
V	2202	4822	130	30613	BAW62
V	2203	4822	130	30613	BAW62
V	2205	4822	130	30613	BAW62
V	2206	4822	130	30613	BAW62
V	2207	4822	130	30613	BAW62
V	2208	4822	130	30613	BAW62
V	2209	4822	130	30613	BAW62
V	2212	4822	130	30613	BAW62
V	2213	4822	130	44246	BC549C
V	2214	4822	130	30613	BAW62
V	2216	4822	130	44246	BC549C
V	2217	4822	130	30613	BAW62
V	2218	4822	130	30613	BAW62
V	2219	4822	130	30613	BAW62
V	2221	4822	130	30613	BAW62
V	2222	4822	130	34173	BZX79-C5V6
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V	2241	4822	130	30613	BAW62
V	2243	5322	130	44127	2N2894A
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V	2251	4322	130	30613	BAW62
V	2252	4822	130	30613	BAW62
V	2253	4822	130	30613	BAW62
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V	2439	4822	130	41084	BF422 PH
V	2441	4822	130	30613	BAW62
V	2442	4822	130	41084	BF422 PH
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V	2444	4822	130	41084	BF422 PH
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V	2453	4822	130	40824	BD140
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V	2457	5322	130	34297	BZX79-C10
V	2458	5322	130	44396	BF324
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V	2461	4822	130	44246	BC549C
V	2462	4822	130	44257	BC547
V	2463	4822	130	30613	BAW62
V	2464	4822	130	30613	BAW62

Item	Ordering number	OHM	Tol (%)	Type/description
Integreted circuits				
D 101	5322 209 85475	LM208T		
D 102	5322 116 94021	TF CIRC	UIT	METAL FILM
D 151	5322 209 85475	LM208T		
D 152	5322 116 94021	TF CIRC	UIT	METAL FILM
D 201	5322 209 85484	OQ 012		
D 202	5322 209 85484	OQ 012		
D 203	5322 209 85484	OQ 012		
D 301	5322 209 85484	OQ 012		
D 302	5322 209 85484	OQ 012		
D 303	5322 209 85484	OQ 012		
D 401	5322 209 85484	OQ 012		
D 451	5322 209 85484	OQ 012		
D 501	5322 209 85484	OQ 012		
D 601	5322 209 85484	OQ 012		
L 602	5322 216 54192	OM504		
D 603	5322 255 44246	HIC-P5185	PH	
D 701	5322 209 84659	LM308T	PH	
D 801	5322 209 84659	LM308T	PH	
D 802	5322 209 85484	OQ 012		
D 901	5322 209 85956	10231BA	SC	
D 902	5322 209 85955	GXB10102D	SC	
D 903	5322 209 84659	LM308T	PH	
D 904	5322 209 84659	LM308T	PH	
D 906	5322 209 85254	UA741CN	SC	
D 1101	5322 209 84659	LM308T	PH	
D 1201	5322 209 84659	LM308T	PH	
D 1301	5322 209 84659	LM308T	PH	
D 1302	5322 209 84659	LM308T	PH	
D 1303	5322 209 84111	CA3086		
D 1304	5322 209 84659	LM308T	PH	
D 1551	5322 209 84386	TCA220		
D 1552	5322 209 84386	TCA220		
D 1601	5322 209 84823	N74LS00N	SC	
D 1602	5322 209 85312	N74LS02N	SC	
D 1603	5322 209 85312	N74LS02N	SC	
D 1604	5322 209 85527	N74LS76N	SC	
D 1606	5322 209 84823	N74LS00N	SC	
D 1607	5322 209 84823	N74LS00N	SC	
D 1608	5322 209 84823	N74LS00N	SC	
D 1609	5322 209 85527	N74LS76N	SC	
D 1651	5322 209 84386	TCA220		
D 1652	5322 209 84386	TCA220		
D 1901	5322 209 84452	LM709CH		
D 2201	5322 209 14066	HEF4073BP	PH	
D 2202	5322 209 14049	HEF4049BP	PH	
D 2203	5322 209 14046	HEF4011BP	PH	
D 2204	5322 209 14406	HEF40175BP	PH	
D 2207	5322 209 14046	HEF4011BP	PH	
D 2208	5322 209 10002	HEF4013BP	PH	
D 2209	5322 209 14054	HEF4081BP	PH	
D 2211	5322 209 14054	HEF4081BP	PH	
D 2212	5322 209 14049	HEF4049BP	PH	
D 2213	5322 209 14068	HEF4050BP	PH	
D 2214	5322 209 14046	HEF4011BP	PH	
D 2216	5322 209 10002	HEF4013BP	PH	
D 2217	5322 209 14049	HEF4049BP	PH	
D 2221	5322 209 85899	LM324N		
D 2223	5322 209 14443	HEF4104BP	PH	
D 2224	5322 209 14066	HEF4073BP	PH	
D 2226	5322 209 14049	HEF4049BP	PH	
D 2227	5322 209 14125	HEF4047BP	PH	
D 2228	5322 209 14049	HEF4049BP	PH	
D 2229	5322 209 10002	HEF4013BP	PH	
D 2231	5322 209 14054	HEF4081BP	PH	
D 2401	5322 209 14104	HEF4066BP	PH	
D 2402	5322 209 14104	HEF4066BP	PH	
D 2403	5322 209 14104	HEF4066BP	PH	
D 2406	5322 209 85899	LM324N		

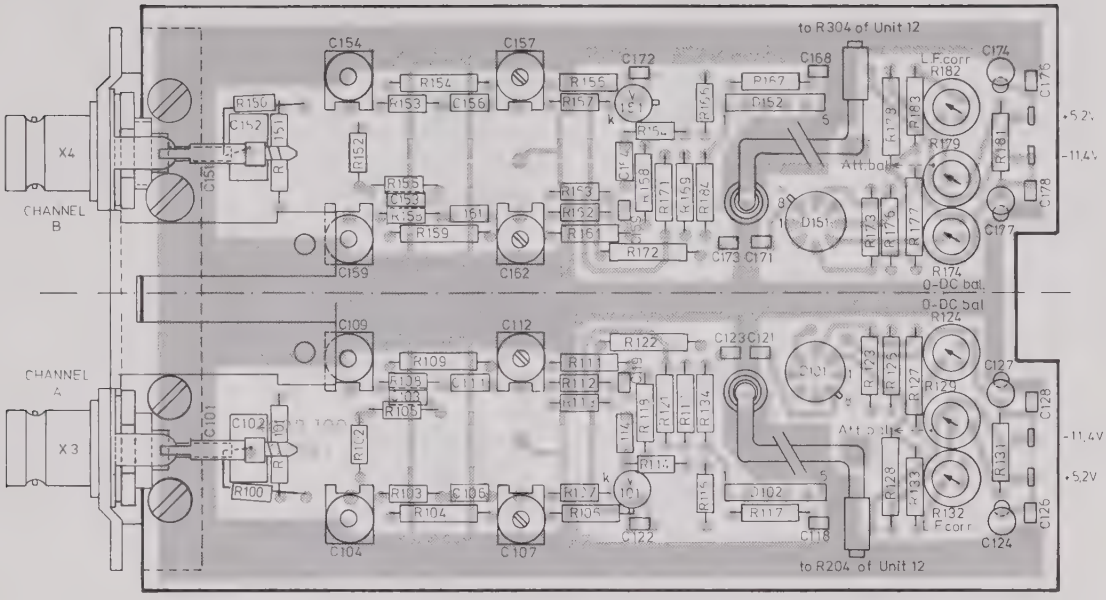


Fig. 3.44. Vertical attenuator (Unit 2), component side lay-out

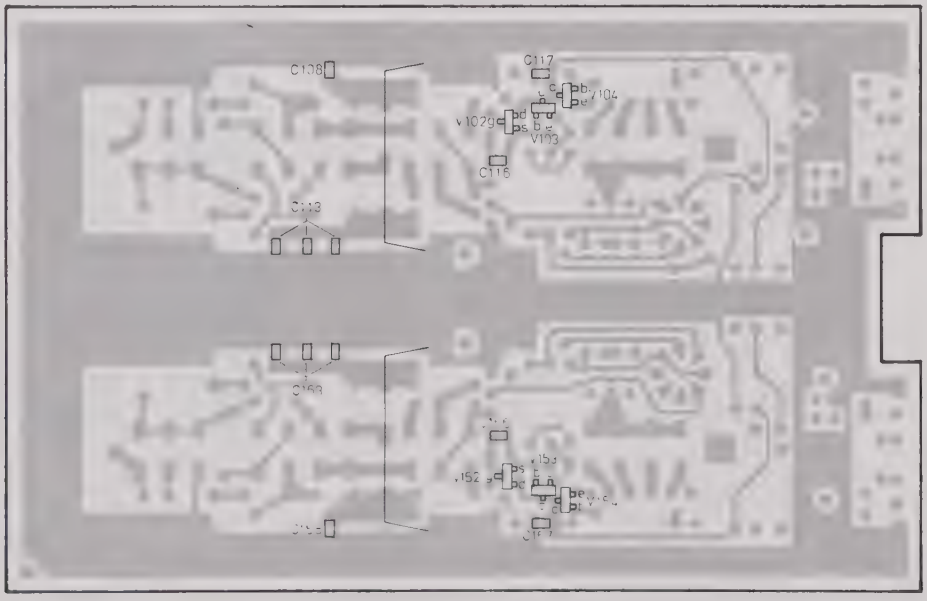


Fig. 3.45. Vertical attenuator (Unit2), conductor side lay-out.

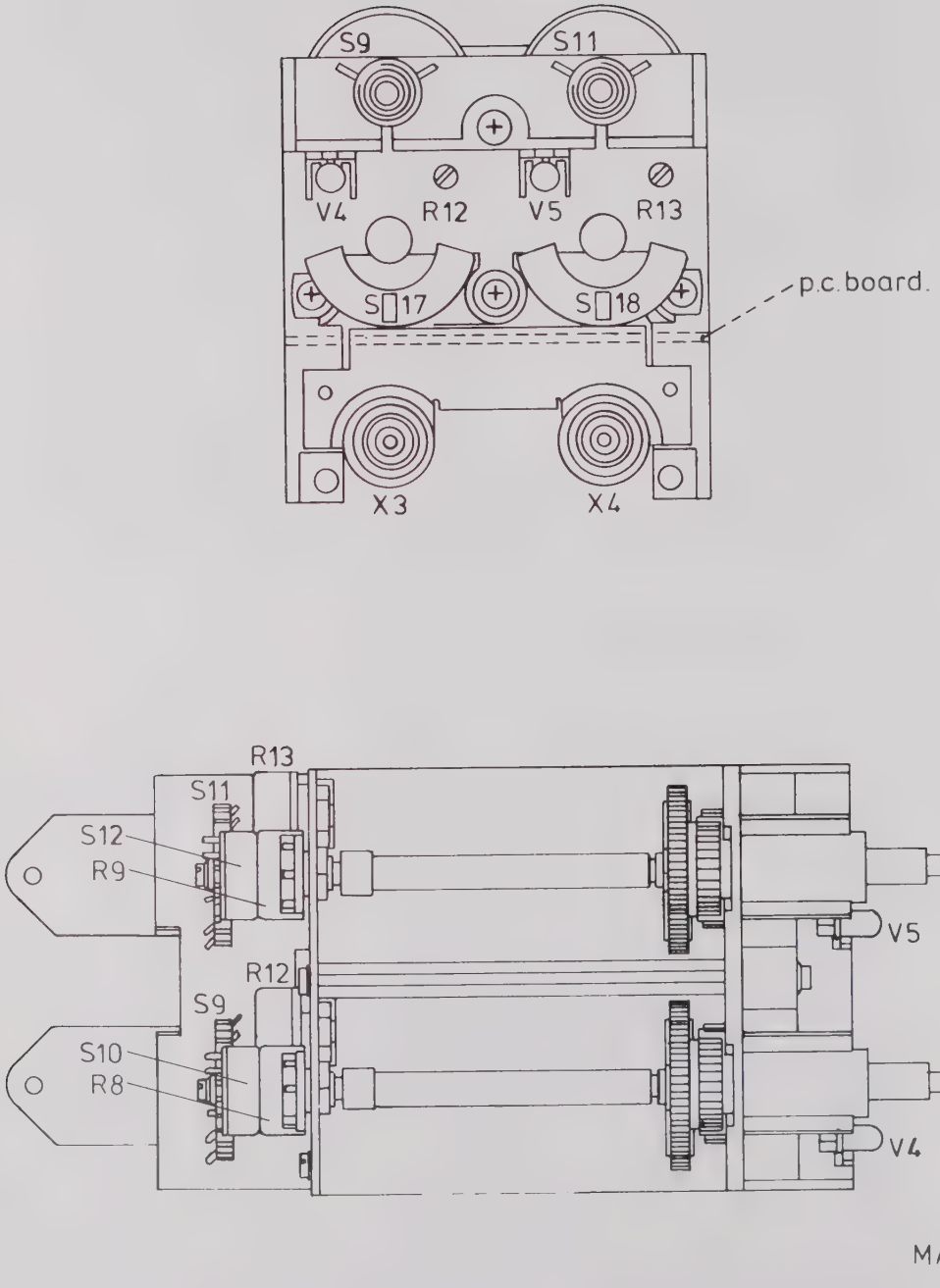


Fig. 3.46. Vertical attenuator (Unit 2)

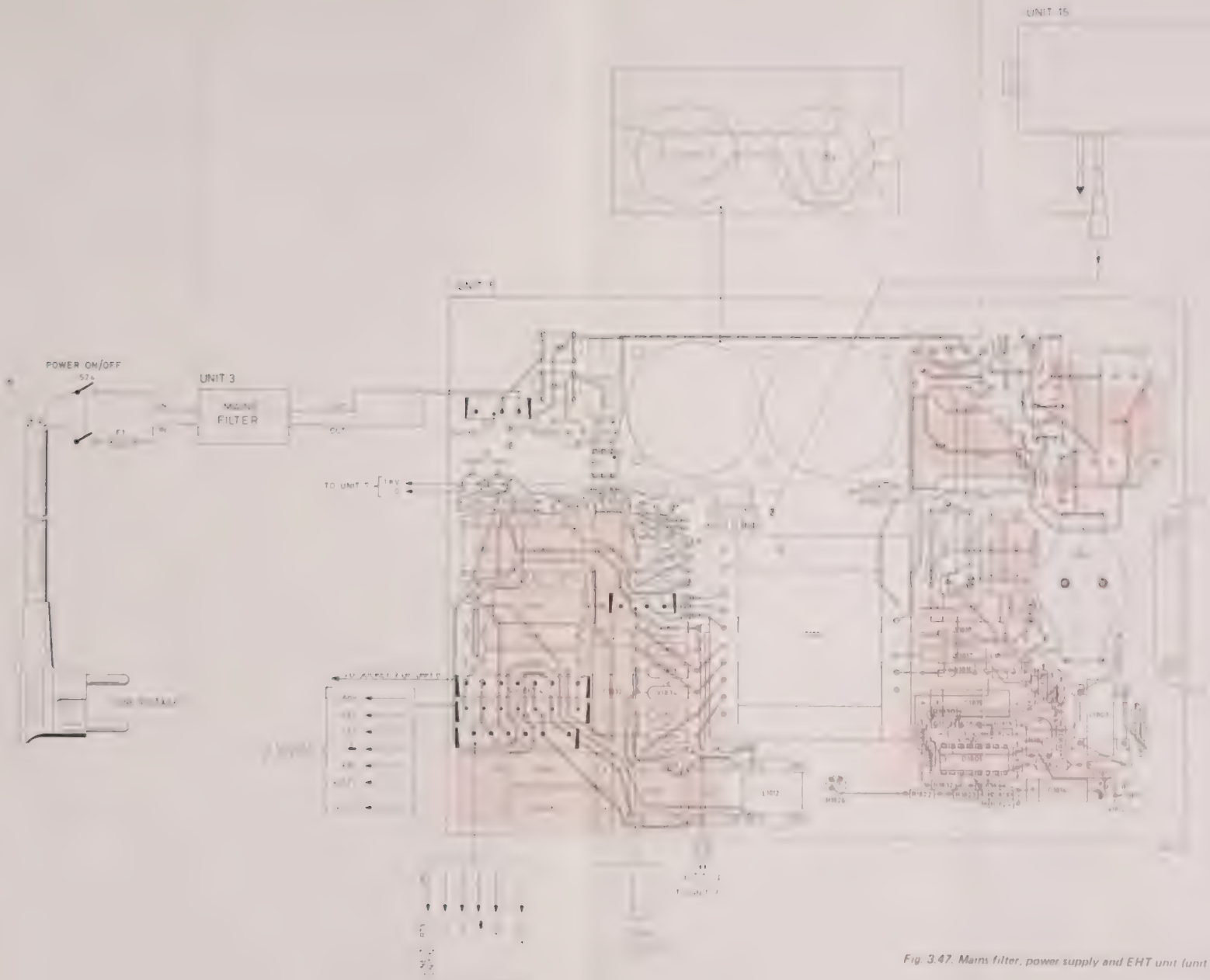


Fig. 3.47. Mains filter, power supply and EHT unit (unit 3.5 and 15), lay-out.

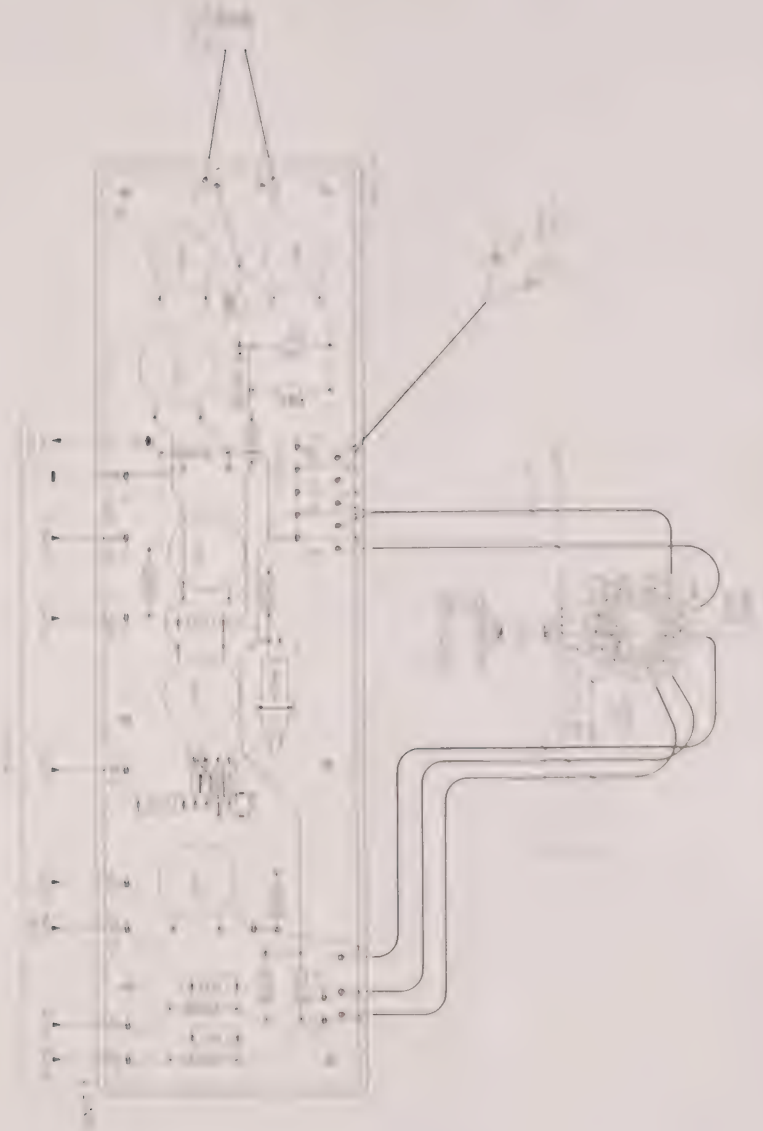


Fig. 3.48 Focus unit (unit 7, lay-out).

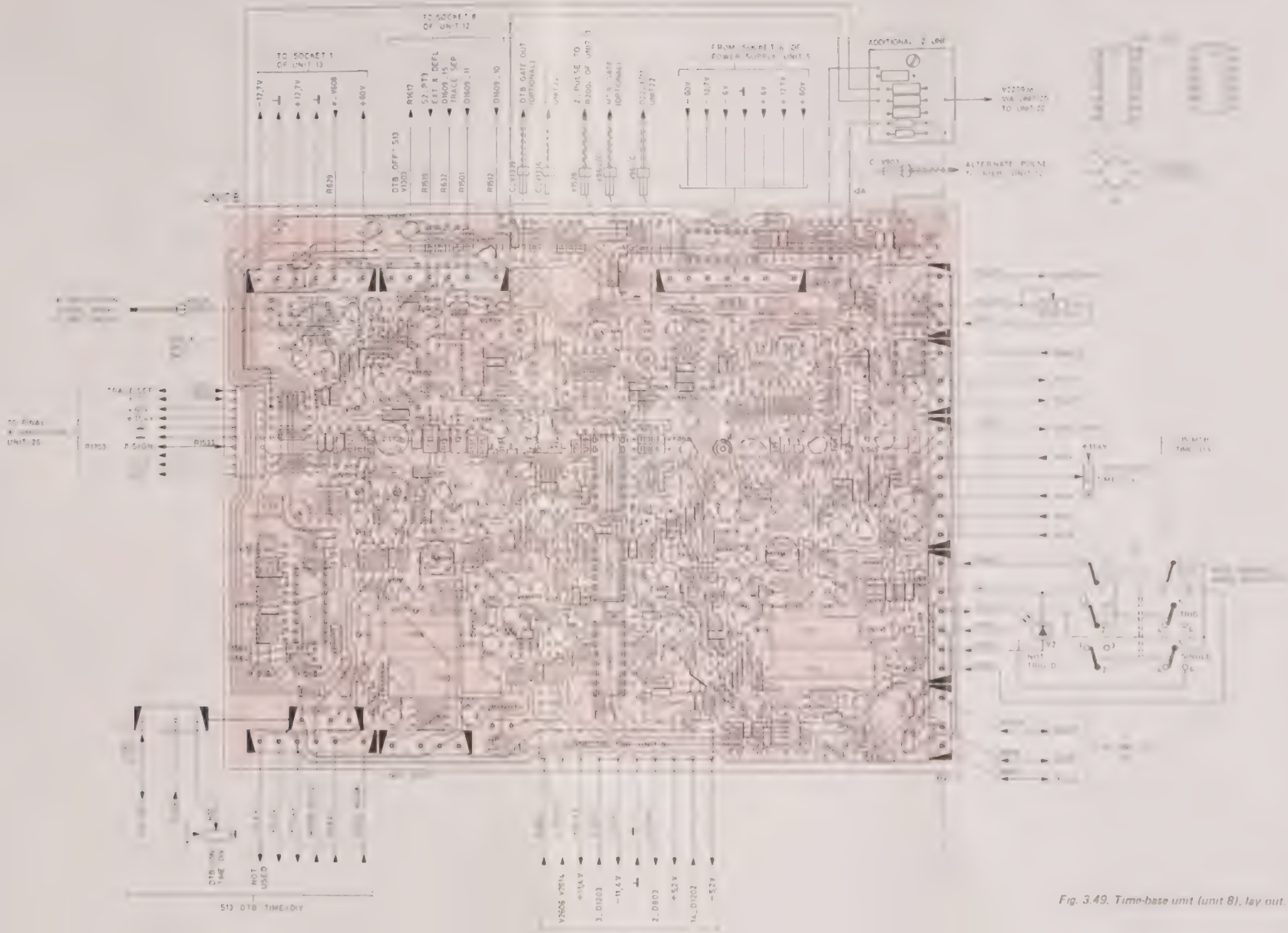


Fig. 3.49. Time-base unit (unit 8), lay out.

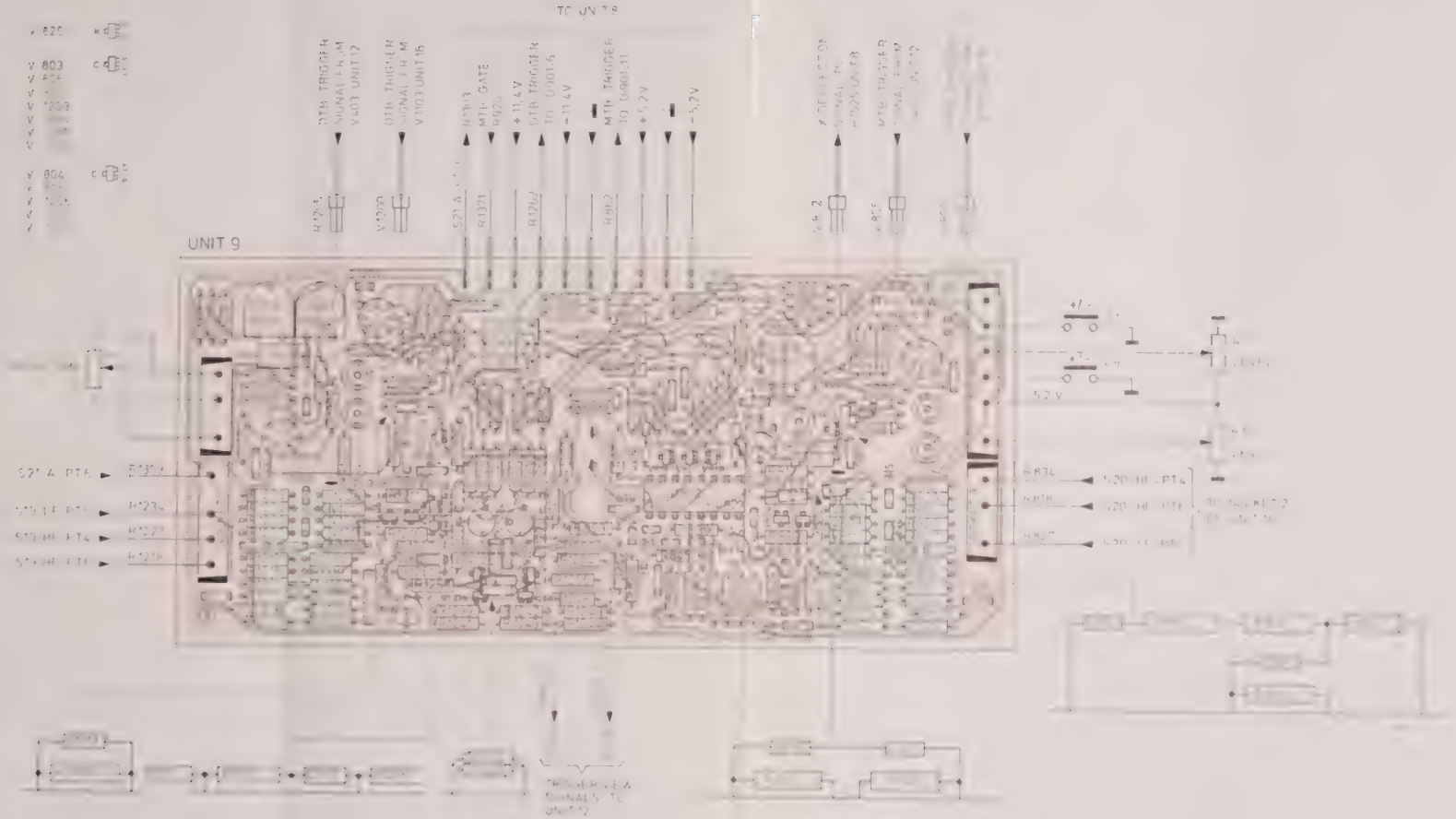


Fig. 3.50. Trigger amplifier (unit 9), lay-out

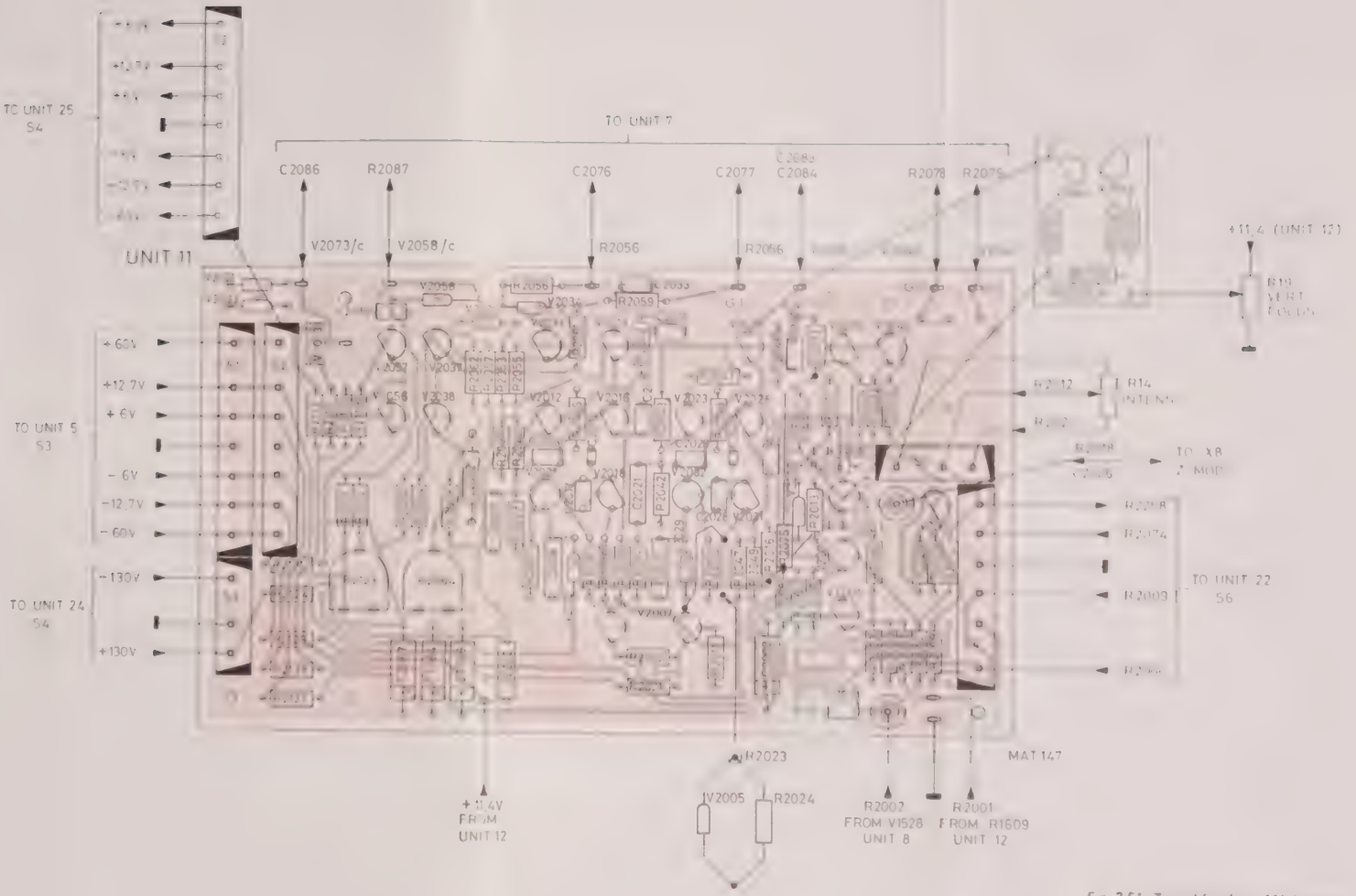


Fig. 3.51. Z amplifier (unit 11), lay-out

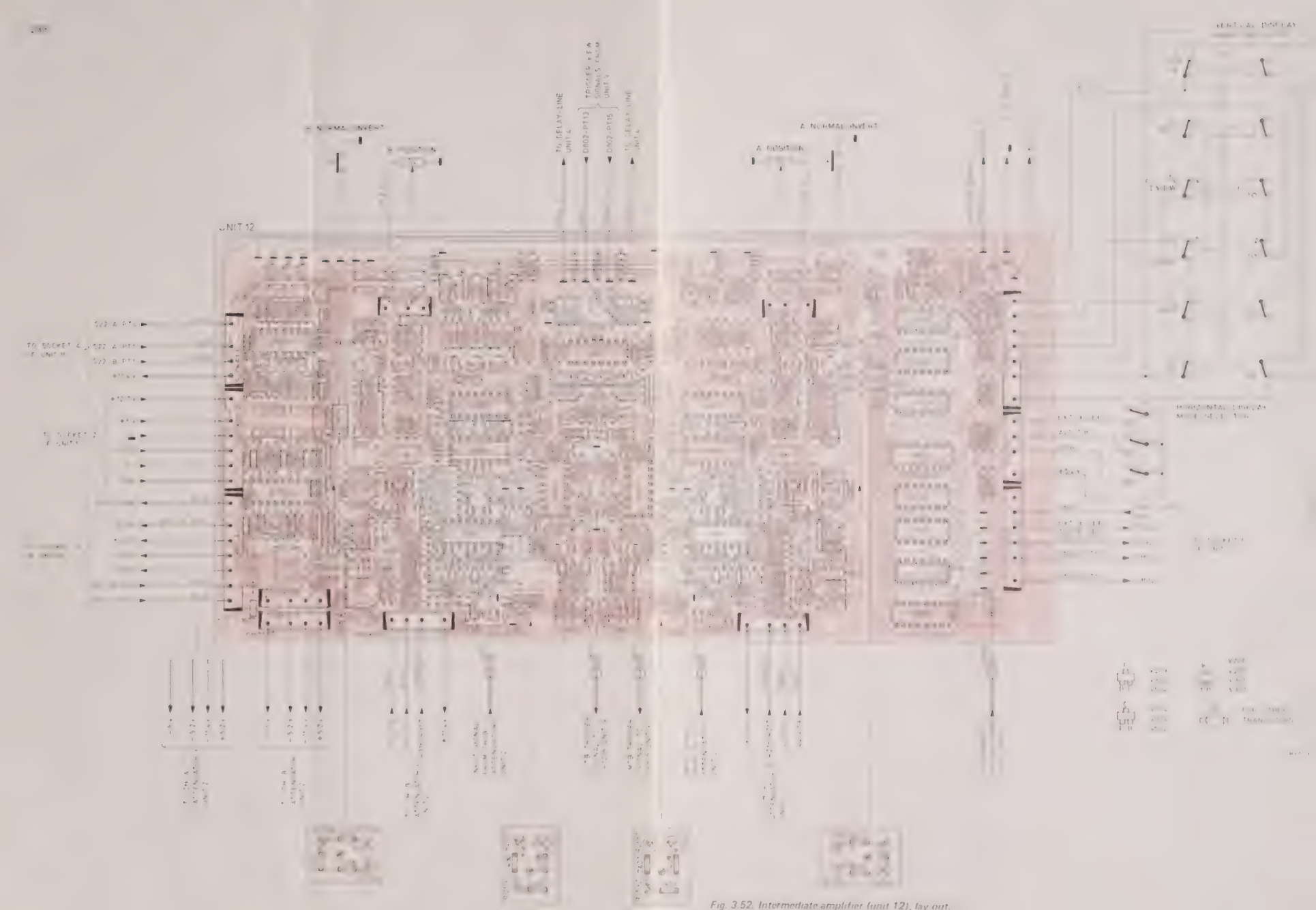


Fig. 3.52. Intermediate amplifier (unit 12), lay out.

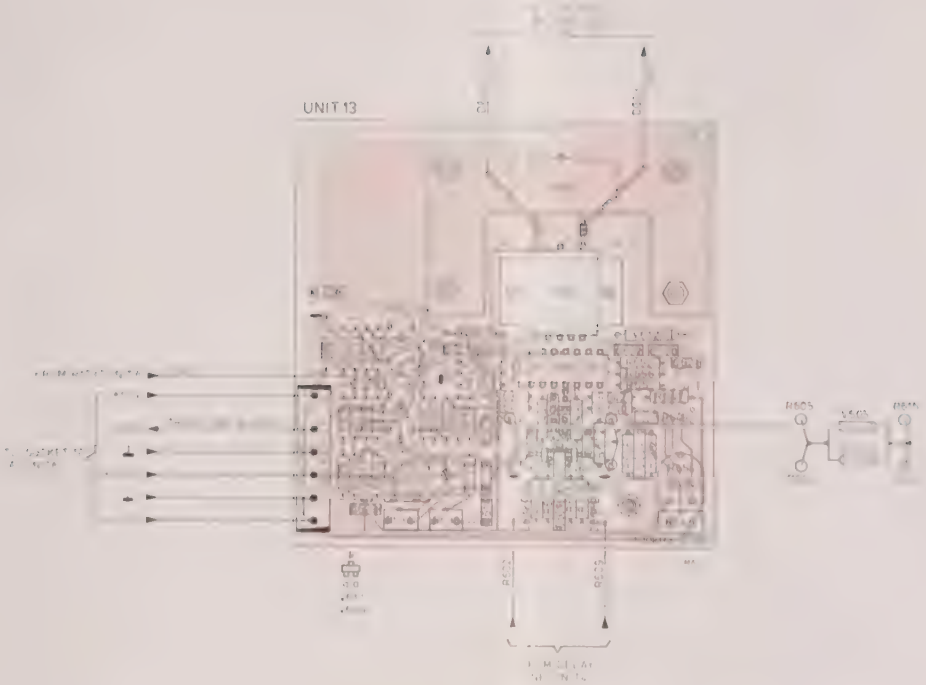


Fig. 3.53. Final Y-amplifier (unit 13), lay out

Fig. 3.54. Trigger source unit (unit 16), lay-out

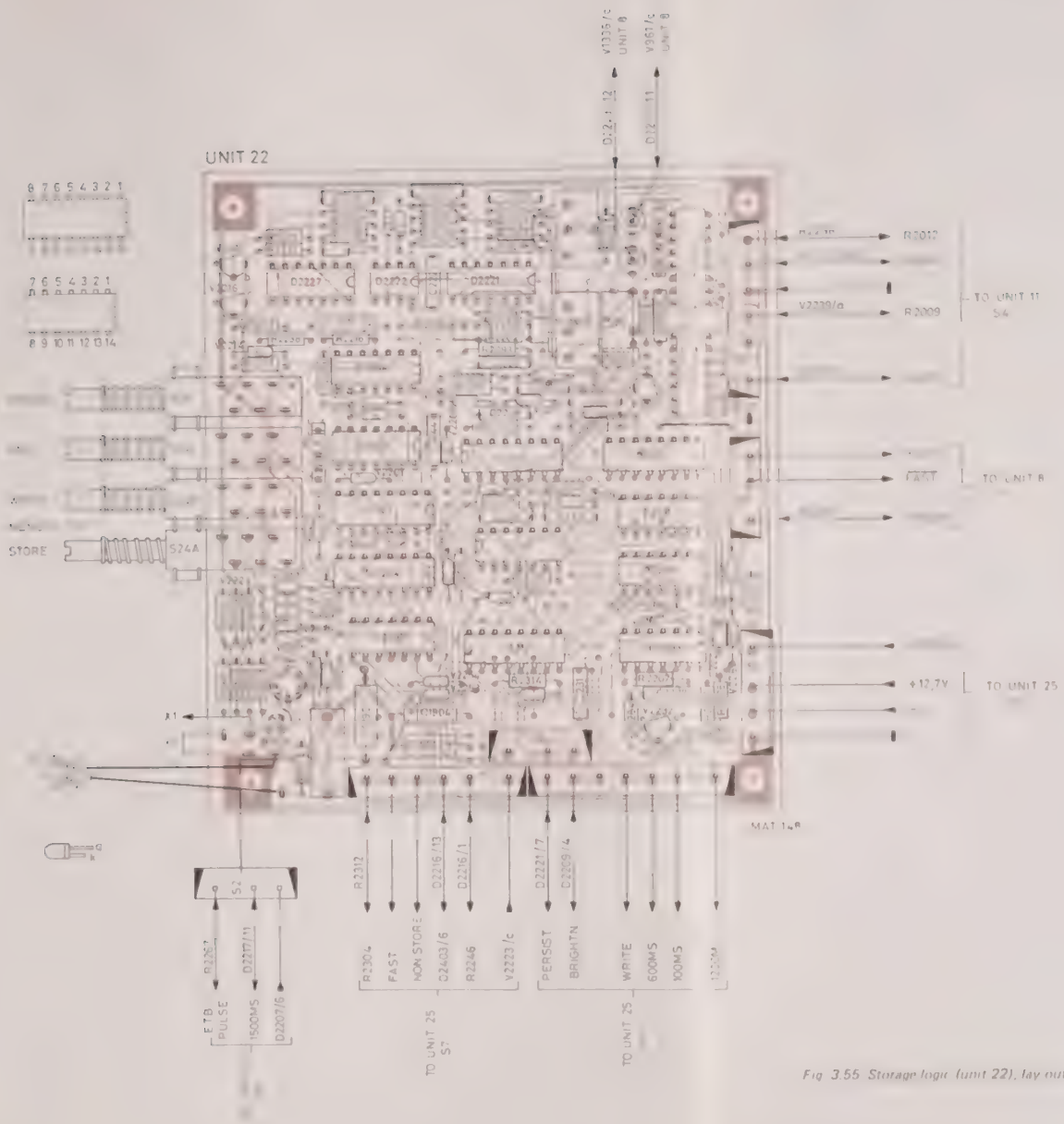


Fig. 3.55 Storage logic (unit 22), lay out

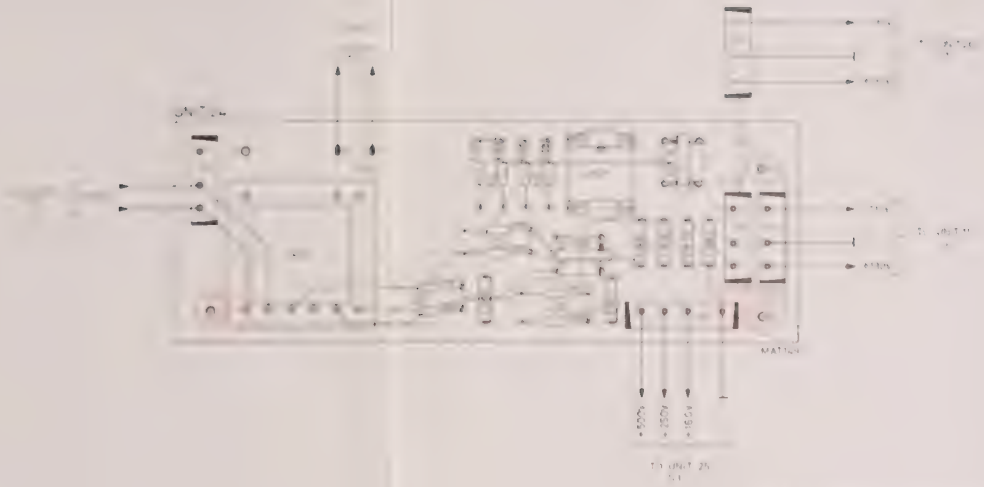


Fig. 3.56. Additional power supply (unit 24), lay out

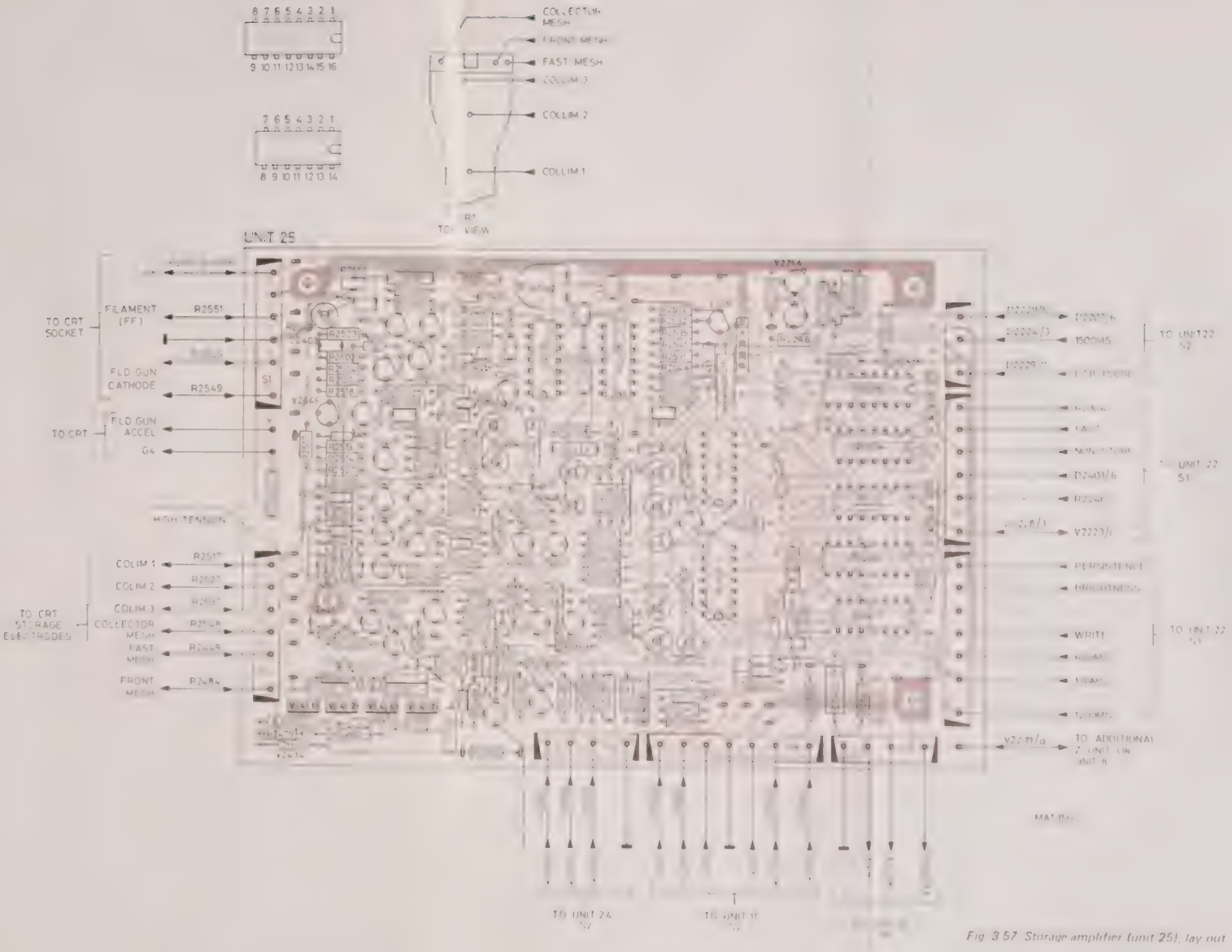


Fig. 3.57. Storage amplifier (unit 25), lay out

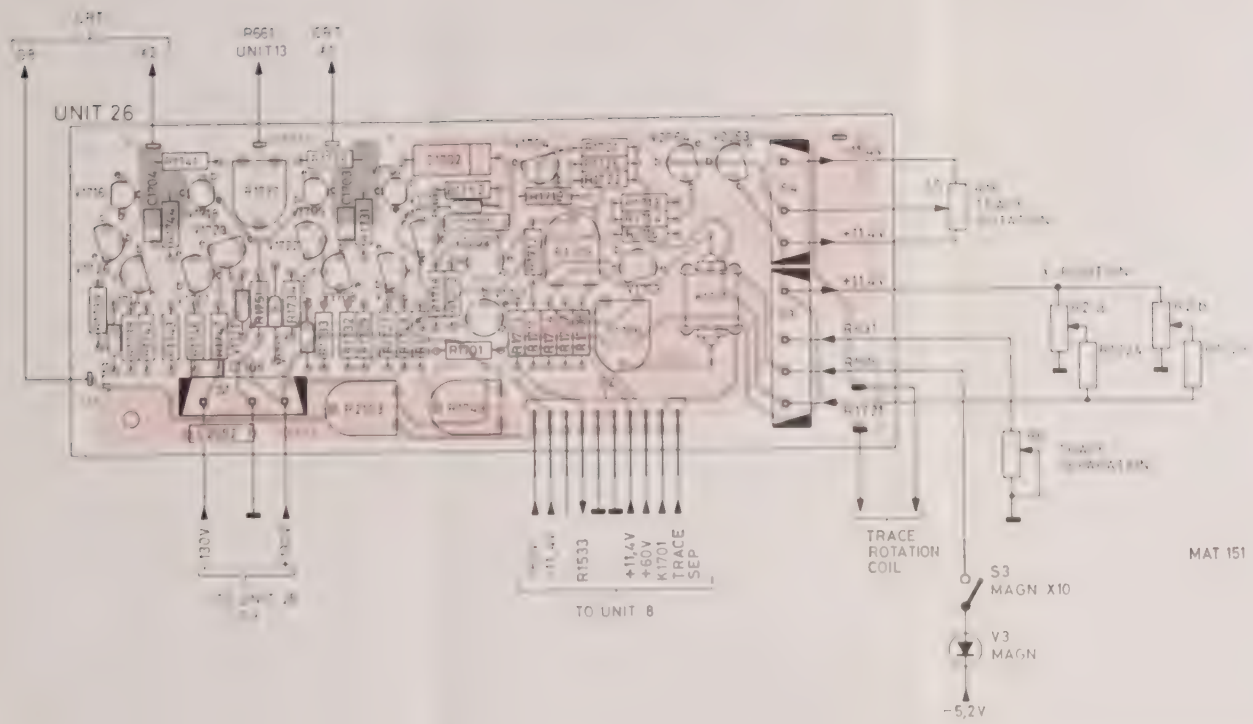
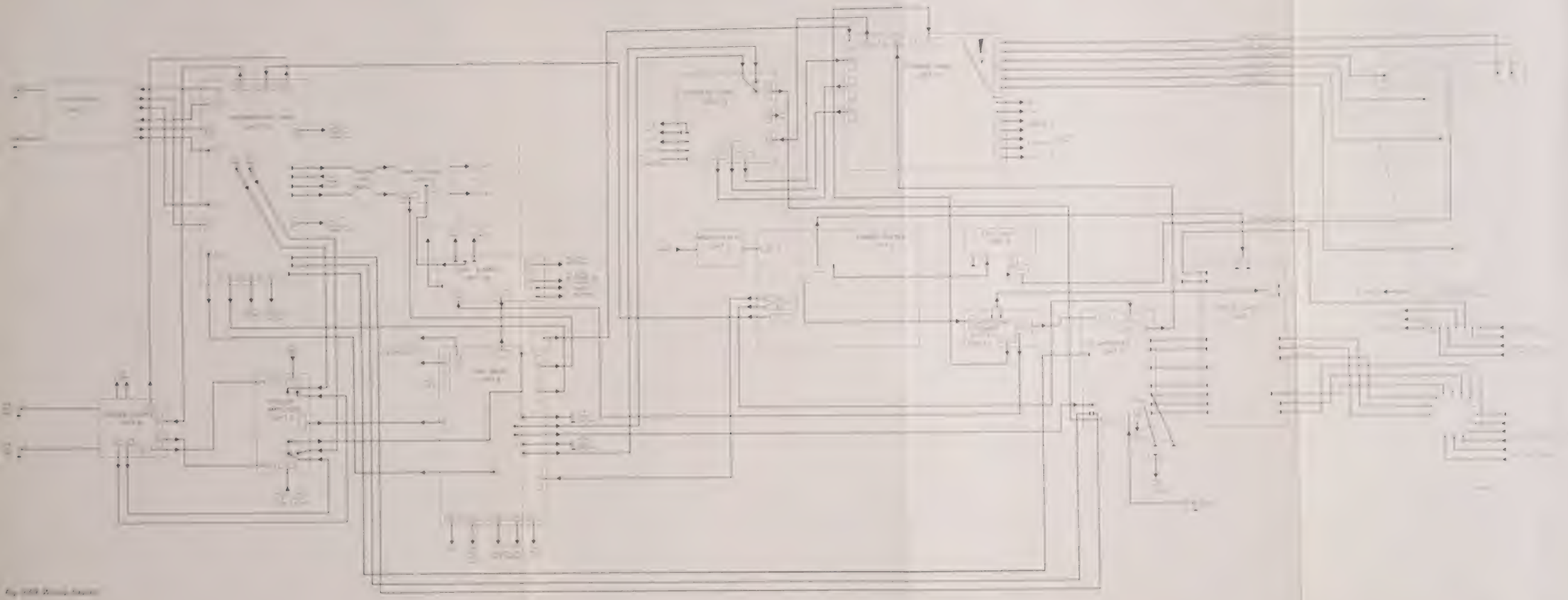
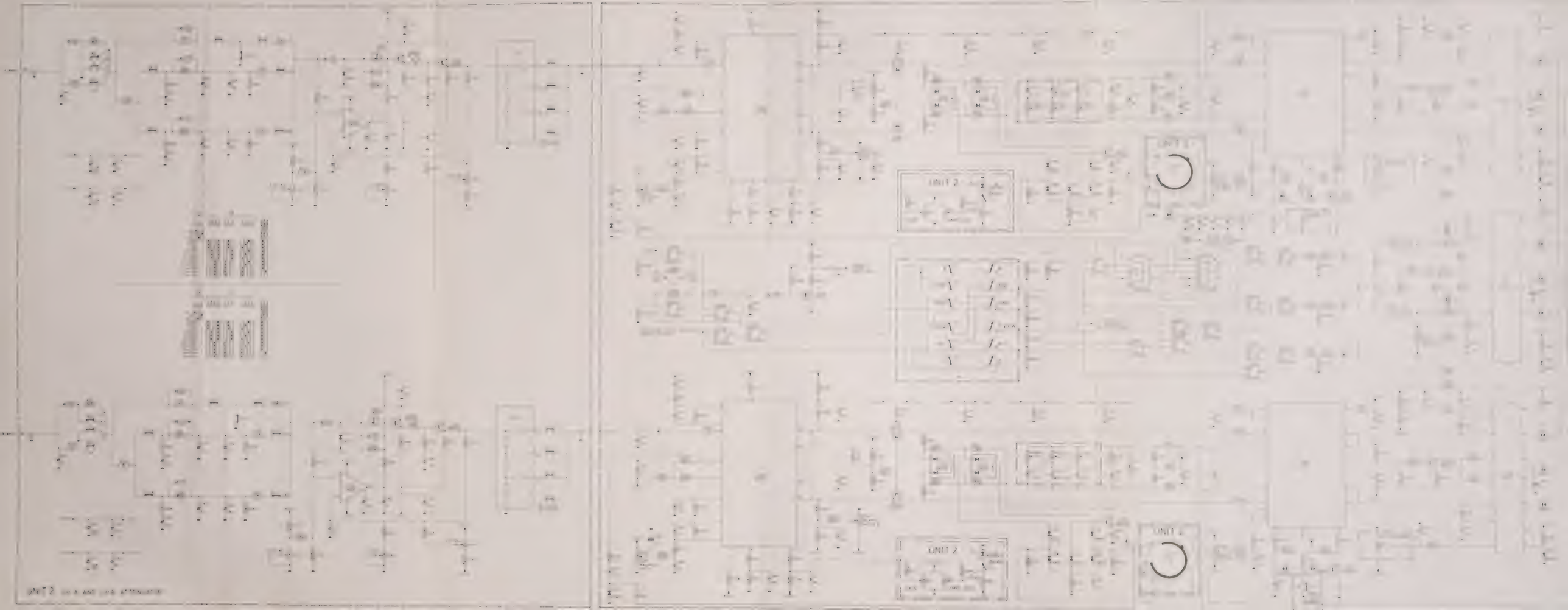
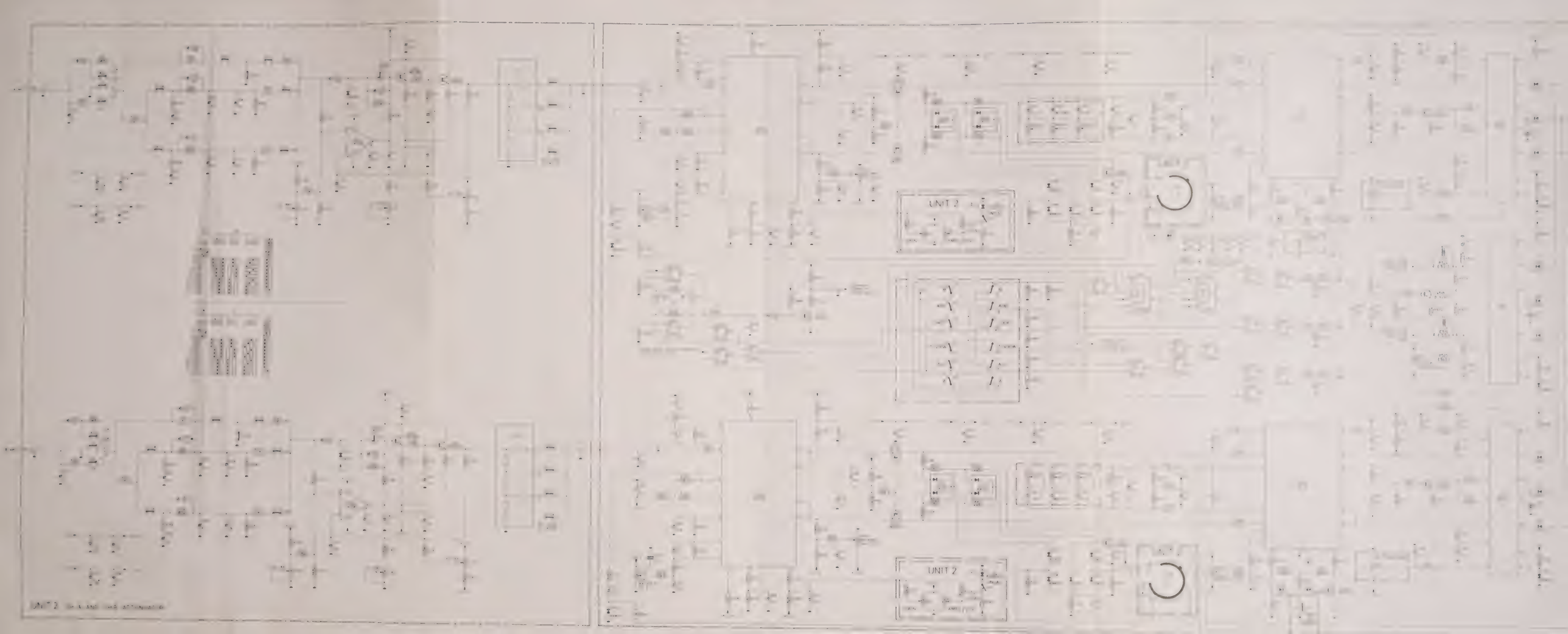


Fig 3.58 Final X-amplifier (unit 26), lay out




UNIT 2
UNIT 1
UNIT 2
UNIT 1


UNIT 2
UNIT 2

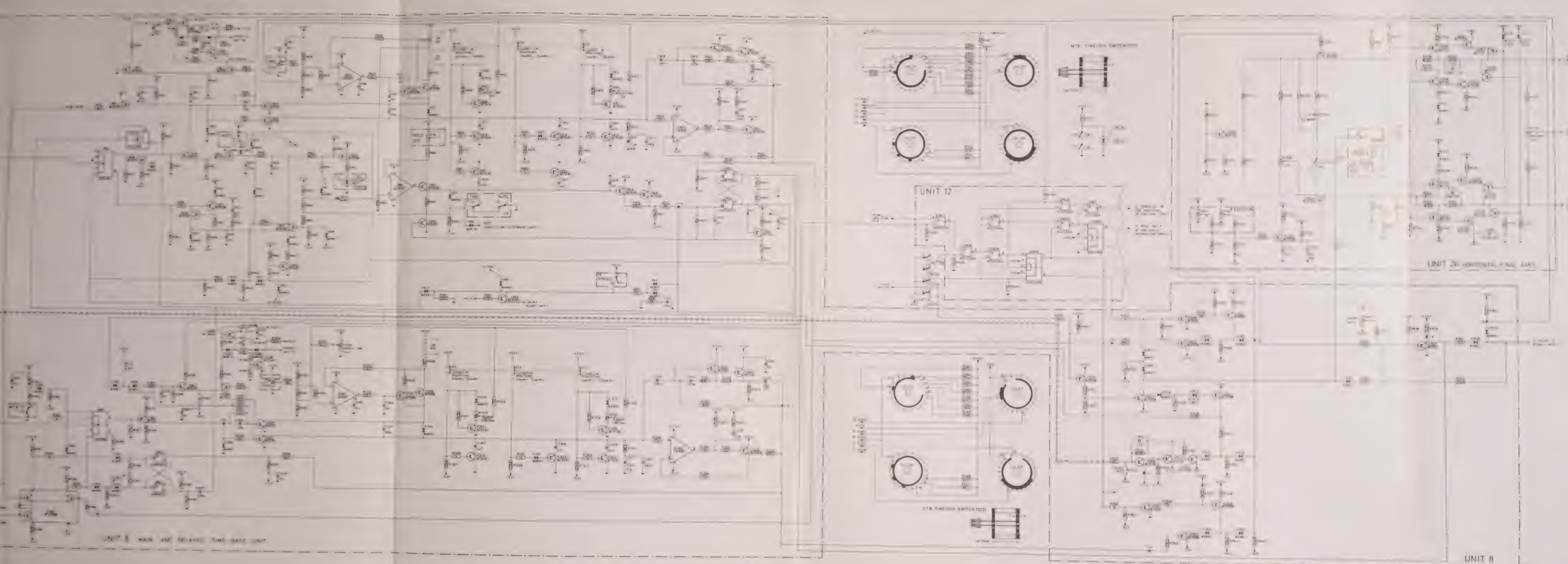
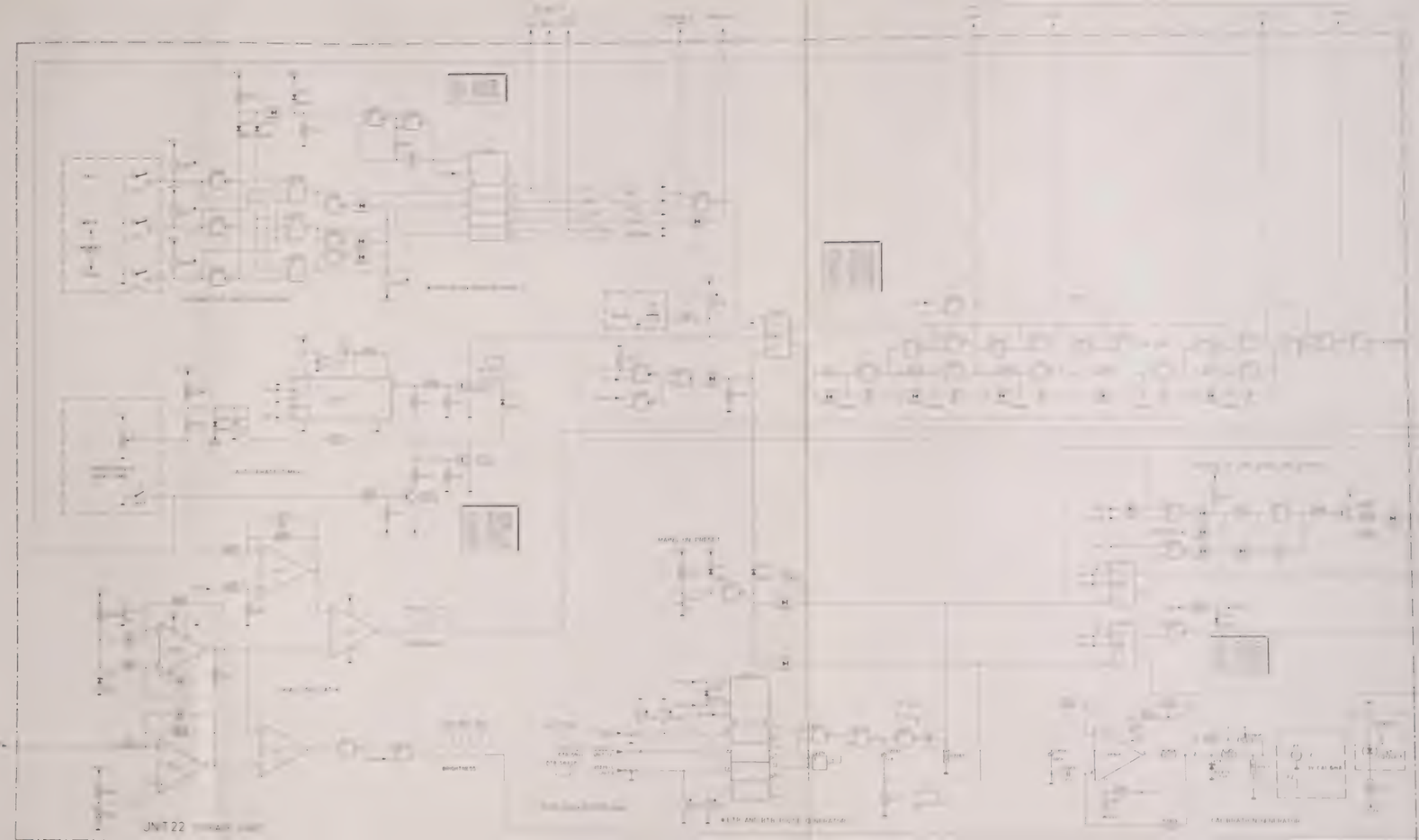
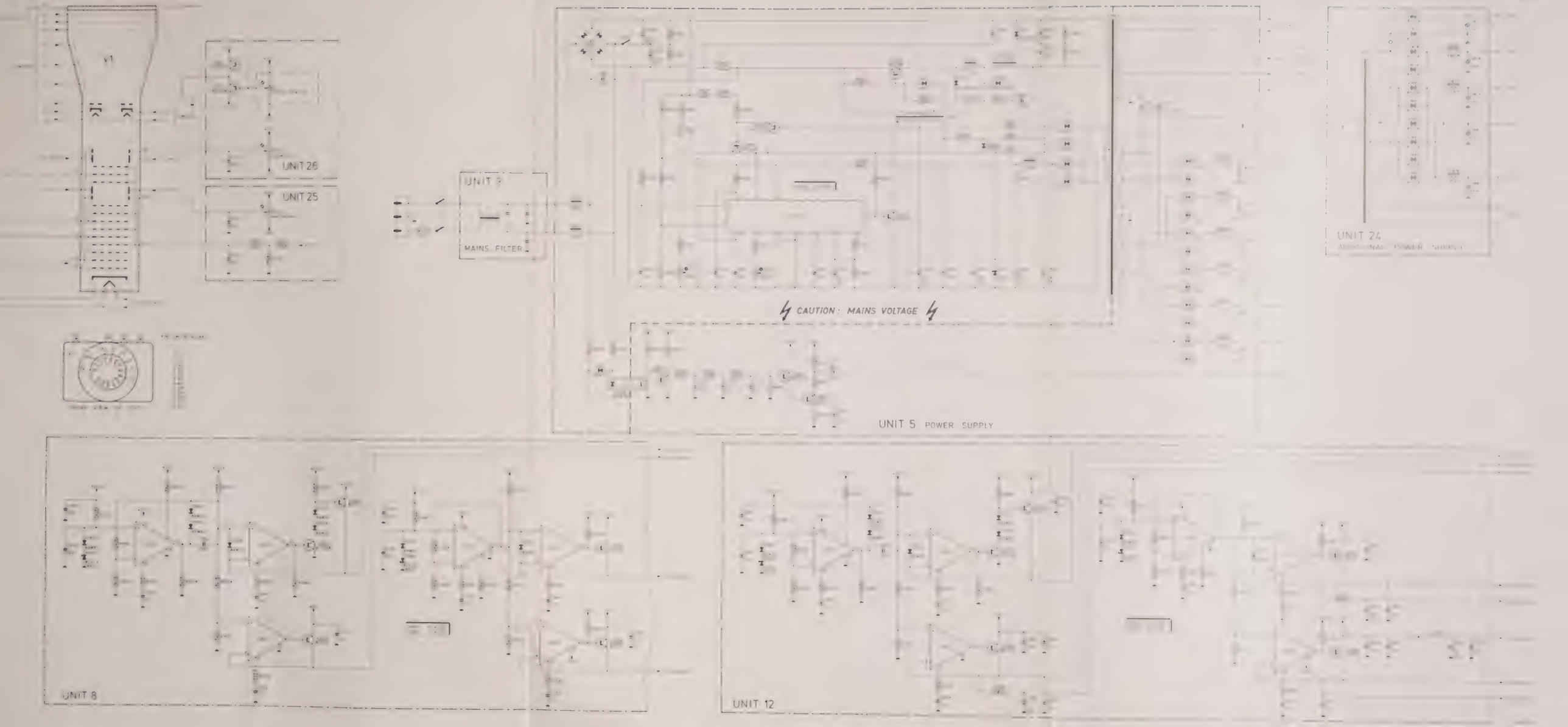


Fig. 3.61. Time bases and horizontal amplifier, circuit diagram




UNIT 26
UNIT 25
UNIT 7
MAINS FILTER
CAUTION : MAINS VOLTAGE
UNIT 5 POWER SUPPLY
UNIT 24
UNIT 8
UNIT 12

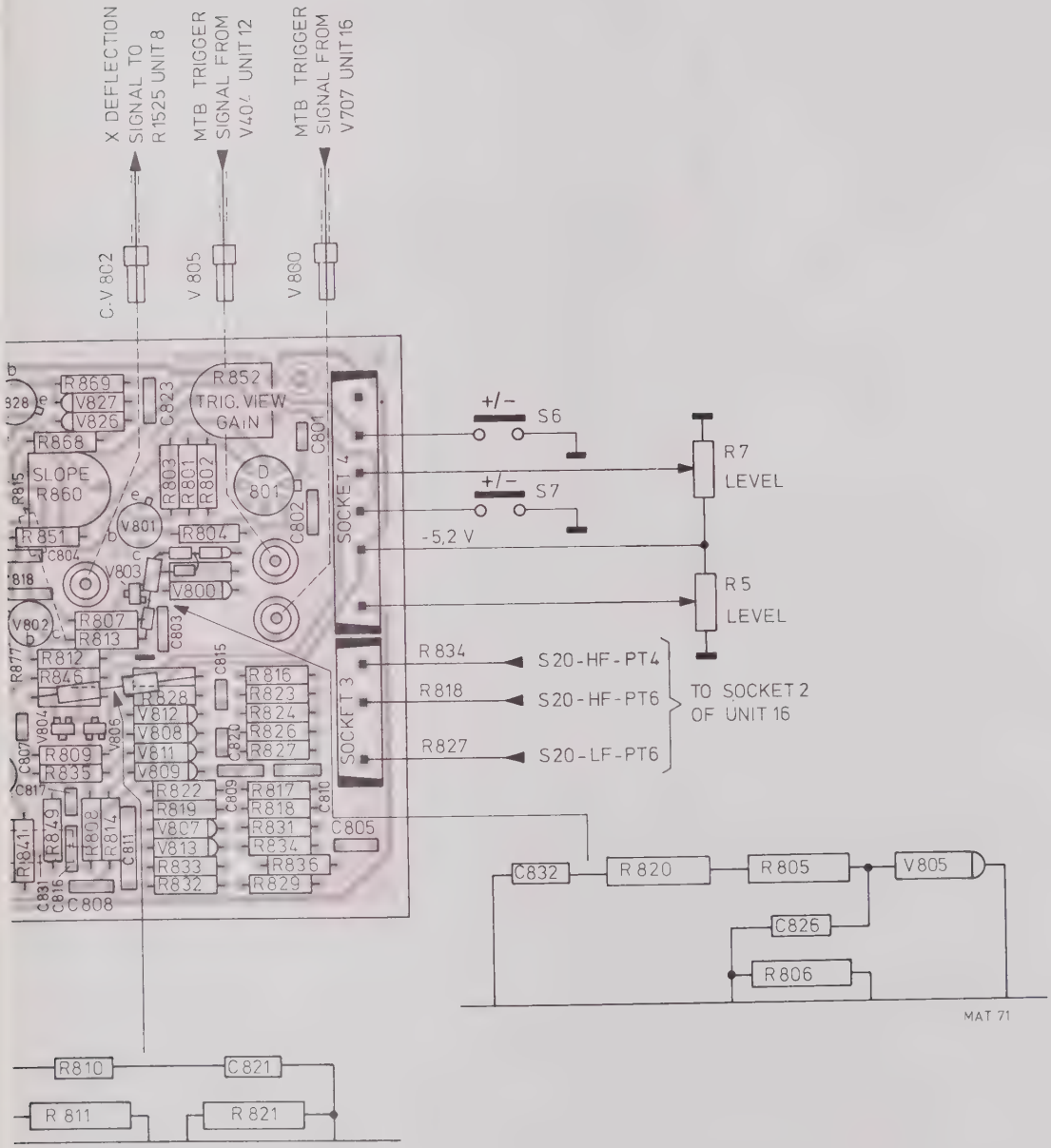


Fig. 3.50. Trigger amplifier (unit 9), lay-out.

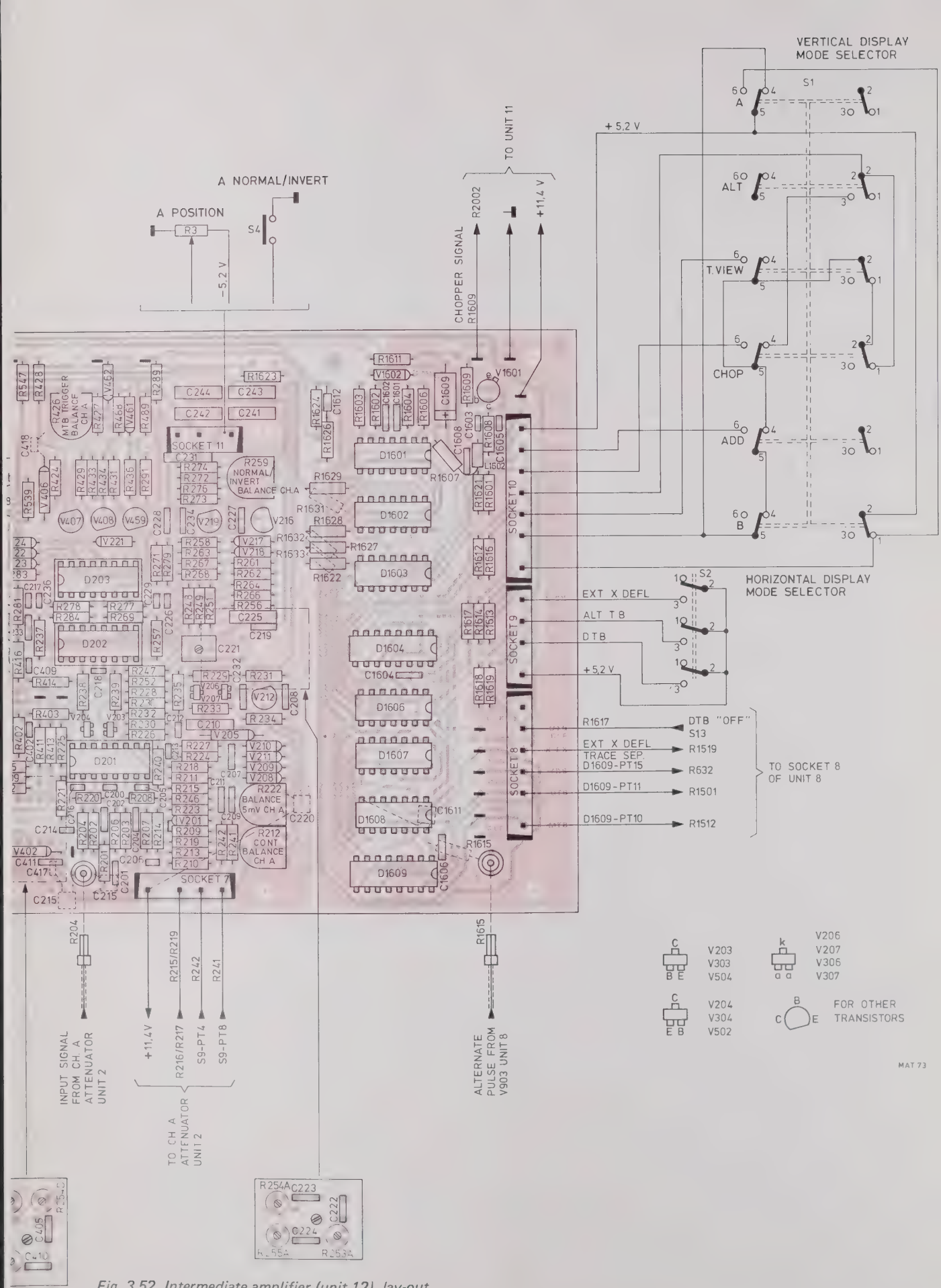


Fig. 3.52. Intermediate amplifier (unit 12), lay-out.

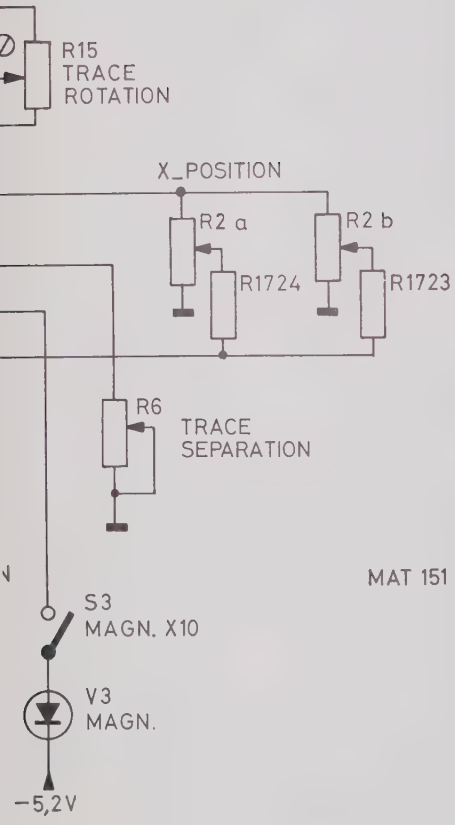


Fig. 3.58. Final X-amplifier (unit 26), lay-out.

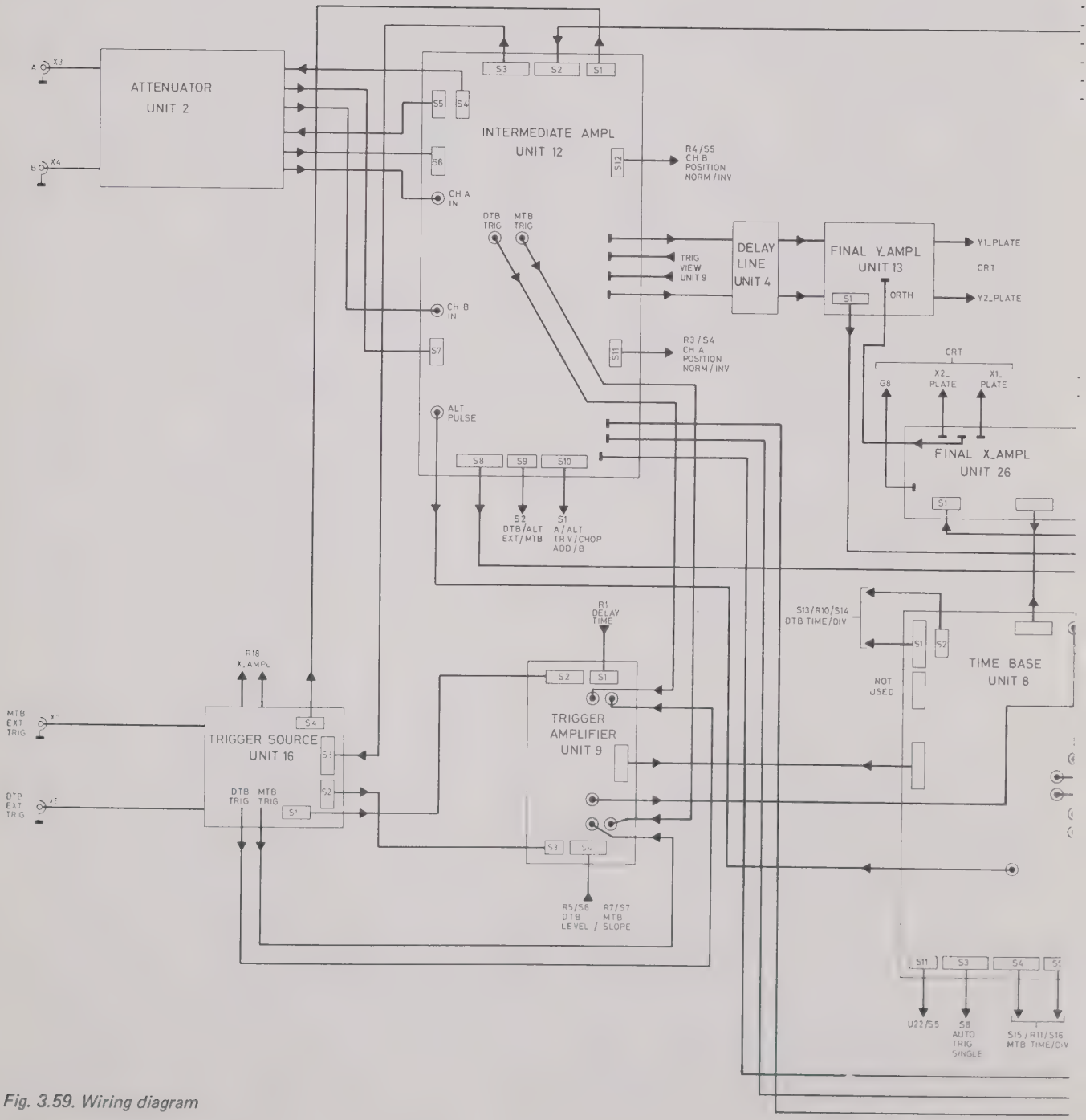
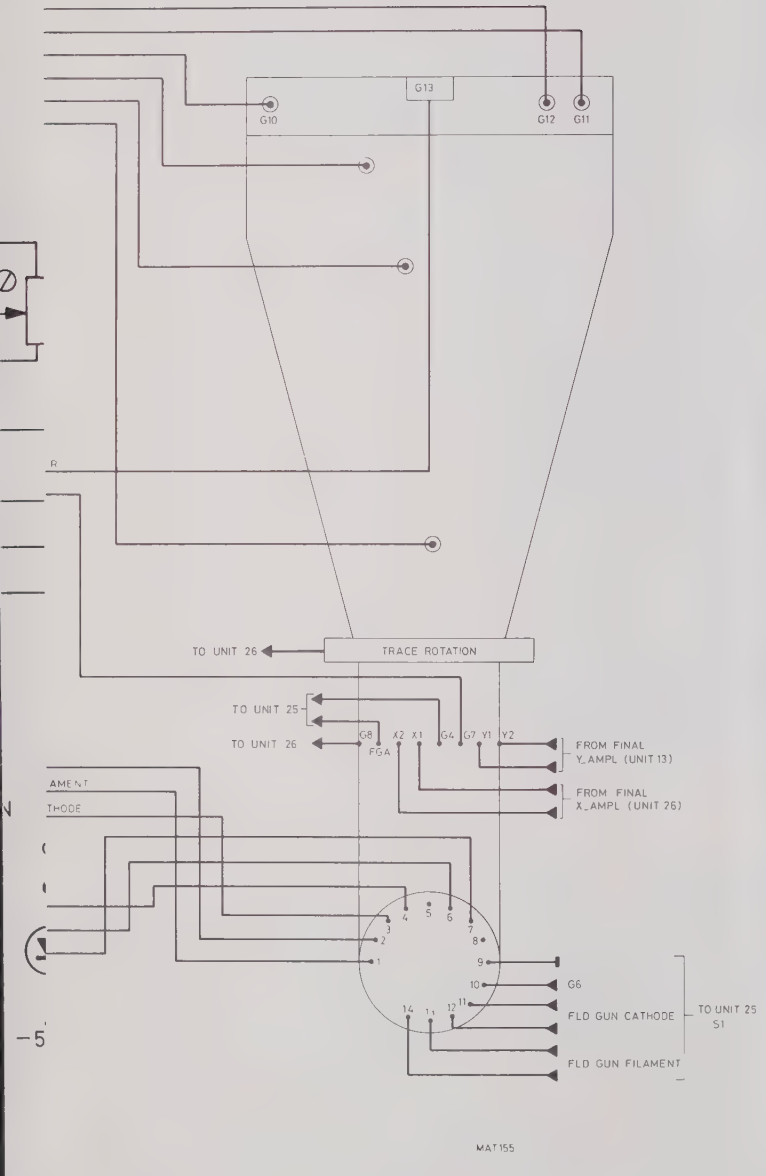
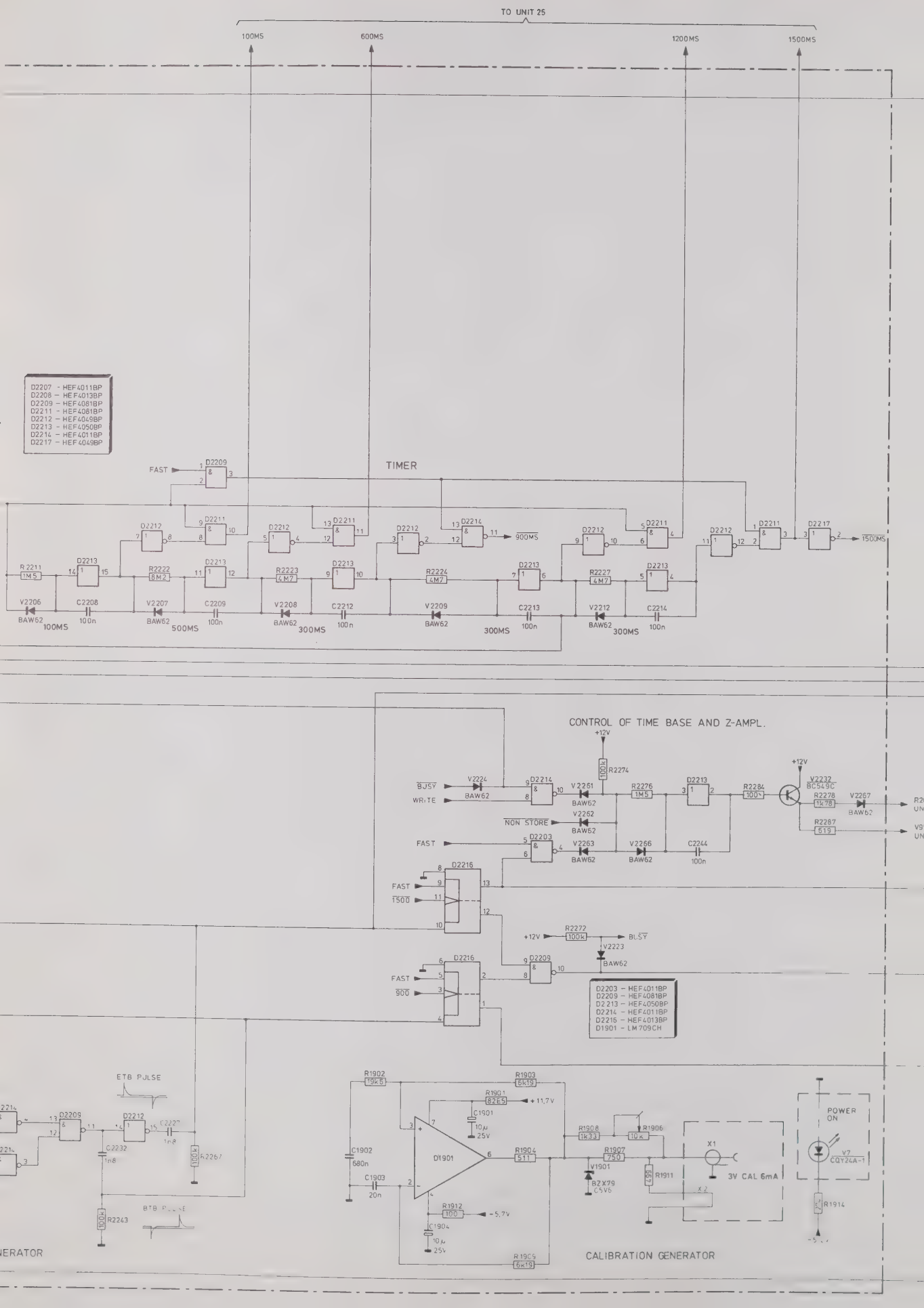


Fig. 3.59. Wiring diagram


G13
G10
G12
G11
TO UNIT 26
TRACE ROTATION
TO UNIT 25
TO UNIT 26
G8
FGA
X2
X1
G4
G7
Y1
Y2
FROM FINAL
Y_AMPL (UNIT 13)
FROM FINAL
X_AMPL (UNIT 26)
G6
FLD GUN CATHODE
TO UNIT 25
S1
FLD GUN FILAMENT

MAT155


TO UNIT 25
100MS
600MS
1200MS
1500MS
D2207 - HEF4011BP
D2208 - HEF4013BP
D2209 - HEF4081BP
D2211 - HEF4081BP
D2212 - HEF4049BP
D2213 - HEF4050BP
D2214 - HEF4011BP
D2217 - HEF4049BP
TIMER
FAST
900MS
1500MS
R2211 1M5
R2222 6M2
R2223 4M7
R2224 4M7
R2227 4M7
V2206 BAW62
V2207 BAW62
V2208 BAW62
V2209 BAW62
V2212 BAW62
C2208 100n
C2209 100n
C2212 100n
C2213 100n
C2214 100n
100MS
500MS
300MS
300MS
300MS
CONTROL OF TIME BASE AND Z-AMPL.
+12V
R2274 100k
BUSY
WRITE
NON STORE
V2224 BAW62
V2251 BAW62
V2252 BAW62
V2263 BAW62
V2266 BAW62
R2276 1M5
R2284 100k
V2232 BC549C
R2278 1k78
R2287 619
V2267 BAW62
C2244 100n
D2203
D2213
D2214
D2216
1500
900
R2272 100k
V2223 BAW62
BUSY
D2203 - HEF4011BP
D2209 - HEF4081BP
D2213 - HEF4050BP
D2214 - HEF4011BP
D2215 - HEF4013BP
D1901 - LM709CH
ETB PULSE
BTB PULSE
R2232 1n8
R2227 1n8
R2267 100k
R2243 100k
R1902 19k6
R1903 6k19
R1901 82E5
+11,7v
C1901 10µ 25v
C1902 680n
C1903 20n
D1901
R1904 511
R1912 100
-5,7v
C1904 10µ 25v
R1909 6k19
R1908 1k33
R1906 10k
R1907 750
V1901 BZX79 C5V6
R1911 698
X1
3V CAL 6mA
x2
POWER ON
V7 CQY24A-1
R1914 2k2
-5,2v
CALIBRATION GENERATOR

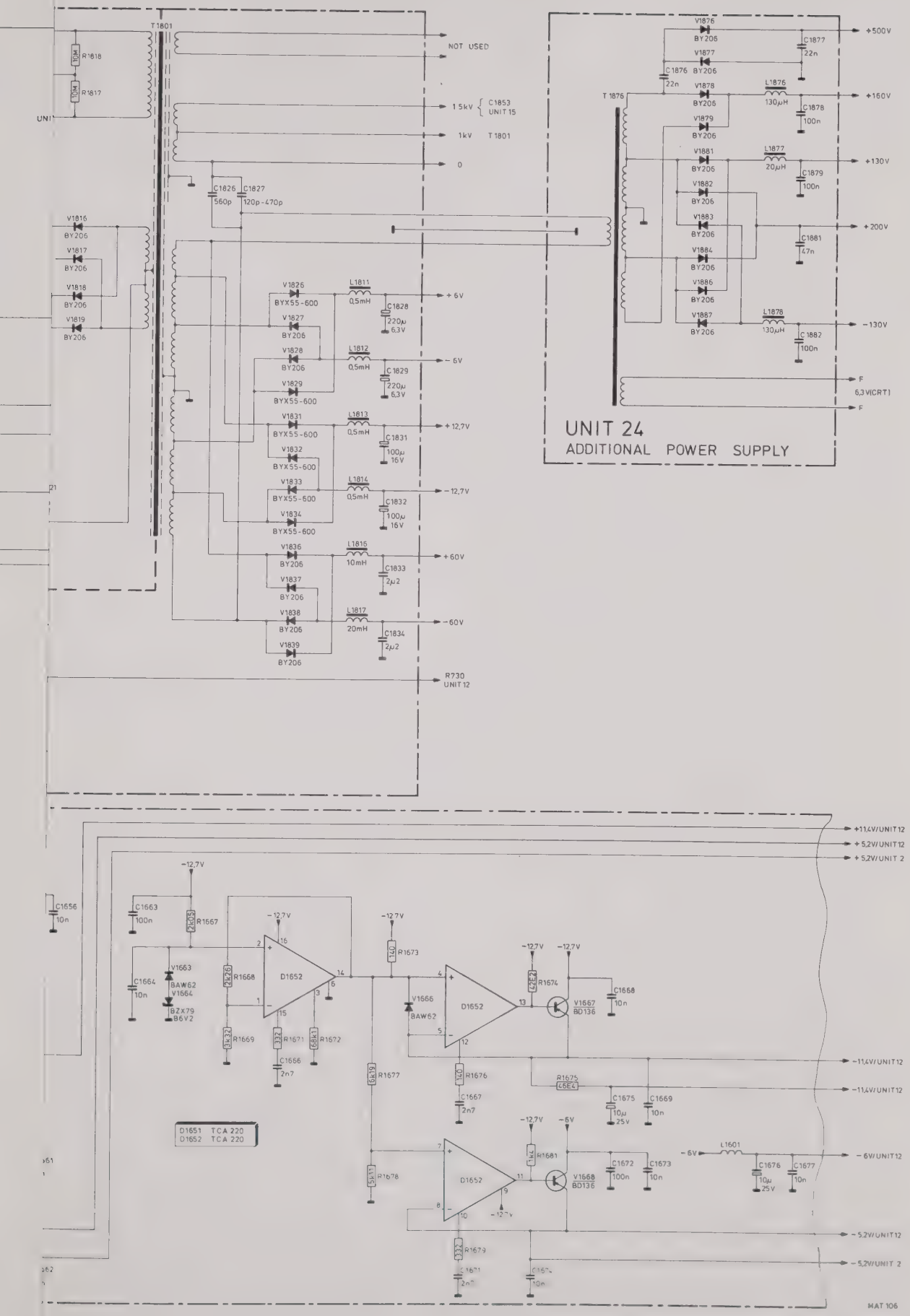


Fig. 3.63. Z-amplifier, focus and power supply, circuit diagram

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐1 2 = 1,2 working hours (1 h 12 min.)

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